2020A
Printer

Instruction Manual

Make a master

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NOTE

This manual documents the Model 2020A and its assemblies at the revision levels shown in Appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in Appendix 7A for older assemblies.

2020A
Printer

Instruction Manual

P/N 504027
July 1979

FLUKE®

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WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

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The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Rev. 6/81

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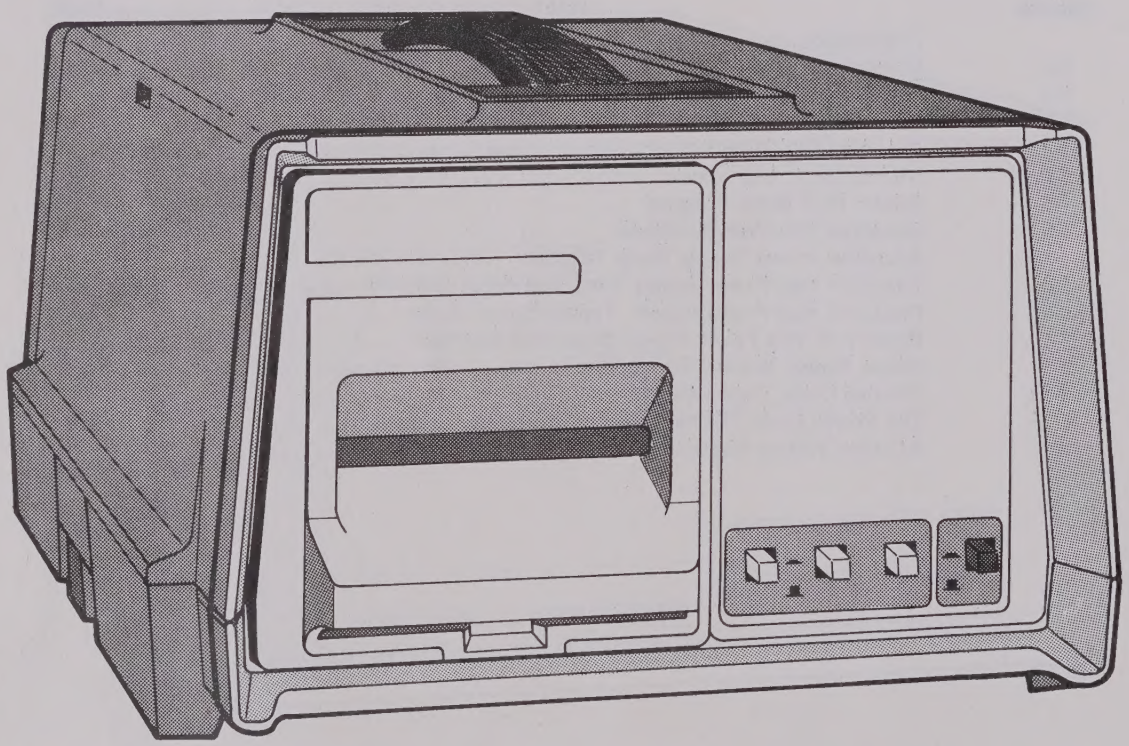


2020A Printer

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 2020A Printer is a 20-character, thermal line printer designed specifically as a recording peripheral device for use with digital measurement instruments. It will print up to 20 characters per line; the character set includes the standard 64-character ASCII set plus special codes to print a degree symbol, Greek letters Mu (μ) and Omega (Ω), and lower case f, k, m, n, p, s, and z. An additional special code can be used to place the 2020A in a plot mode of operation to produce a plot chart reflecting input data variations.

1-3. Five optional interface pcbs are available, allowing use of a wide variety of input test instruments. The five interface options make the printer compatible with test instruments using parallel ASCII format, RS-232-C, IEEE-488, parallel BCD, and PTI data format (PTI is a unique Fluke format). A separate interface pcb is required for each format; each interface converts data received to the ASCII format required by the printer. Only one interface pcb may be installed at one time. For additional interface pcb information, refer to Section 6, Options and Accessories.

1-4. An Interval Timer Option is also available. It allows the operator to select any of several preset time intervals for automatic printer operation. The maximum selectable time interval is eight hours. A remote print command input, independent of the Interval Timer Option, is supplied through a rear panel connector. A switch closure between the two remote print input connections initiates a print cycle.

1-5. Front panel operator controls are provided for printer power, paper advance, single print, and continuous print functions. In the single print mode, the 2020A prints input data only once when the switch is pressed; in the continuous print mode, the 2020A prints input data continuously. If the 2020A is equipped with the Interval Timer Option, front panel controls are provided to select one of four preset print intervals: 10 second, 1 minute, 10 minutes, or 1 hour. Three additional interval controls allow the operator to multiply the base time interval by two, four, or eight. Only one print interval and one multiplier may be selected simultaneously.

1-6. Communication between the printer and the test instrument supplying input data is through a connector on the rear panel. Input connector pin usage is dependent upon the interface option in use. Refer to Section 6 for applicable interface option information.

1-7. Two additional rear panel connectors are used in supplying operating power to the printer. Two input ac voltage ranges are switch selectable. Either an ac line input between 90 and 132 volts, or an ac line input between 180 and 250 volts may be selected. The ac line frequency must be between 47 Hz and 440 Hz. Both ac line inputs use the same connector; the second power connector provides a 12V dc input power connection. Both the ac line and dc input power may be connected simultaneously; the printer will operate from the ac line supply, but if the ac supply fails, the printer will switch automatically to dc operation with no interruption.

1-8. The Model 2020A Printer is housed in a PTI (Portable Test Instrument) case. This lightweight, durable plastic case makes the printer truly portable when used with a portable dc power source. It also may be stacked and latched together with other instruments in PTI cases to form portable test systems.

1-9. Options and accessories for the Model 2020A Printer are listed in Table 1-1. Detailed information concerning each listed option or accessory is given in Section 6 of this manual, Option and Accessory Information.

1-10. SPECIFICATIONS

1-11. Table 1-2 lists specifications for the Model 2020A Printer. Specifications for the interface options and Interval Timer Option are listed in the applicable portion of Section 6.

Table 1-1. Options and Accessories

OPTIONS	DESCRIPTION
2020A-001	Input Interface - Parallel ASCII
2020A-002	Input Interface - RS-232-C
2020A-003	Input Interface - IEEE-488
2020A-004	Input Interface - PTI
2020A-005	Input Interface - Parallel BCD
2020A-006	Interval Timer Option
ACCESSORY	**DESCRIPTION**
Y2028	BCD to PTI Converter (use with Options -001 and -004)
Y2034	Interconnect Box - 5 input connectors, 1 output connector to printer (use with -004)
Y7203	Interconnect Cable - 2 feet, 36-pin
Y7204	Interconnect Cable - 5 feet, 36-pin

Table 1-2. 2020A Printer Specifications

ITEM	SPECIFICATIONS
TYPE	THERMAL
CHARACTER	5 X 7 Dot Matrix
PRINT RATE	3 Lines per second
NUMBER OF COLUMNS	20
LINE SPACING	Approximately 2.5 lines per cm (6 lines per inch).
PAPER ADVANCE MECHANISM	Belt Drive - Stepping Motor
PAPER	Thermal Sensitive, 2.5 inch X 240 foot roll, (3M Type 162)

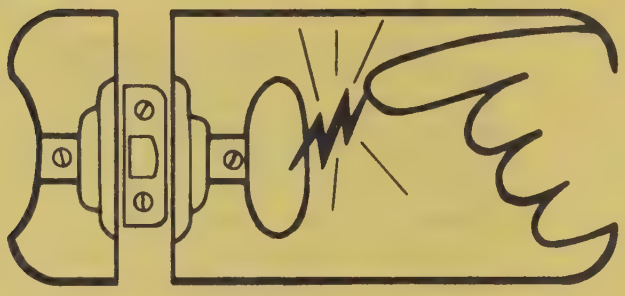
Table 1-2. 2020A Printer Specifications (cont)

ITEM	SPECIFICATIONS
OPERATING ENVIRONMENT TEMPERATURE	0°C to 50°C (32°F to 122°F)
HUMIDITY	95% - 0°C to 25°C (32°F to 77°F) 75% - 25°C to 40°C (77°F to 104°F) 45% - 40°C to 50°C (104°F to 122°F)
INSTRUMENT STORAGE	−20°C to +70°C (−4°F to 158°F)
PAPER STORAGE	22°C (71.6°F), 50% RH (90% contrast - 1 year). 45°C (113°F), 80% RH (90% contrast - 1 week).
WEIGHT	Less than 9 pounds (w/ option and paper).
POWER	90 to 132V ac, 47 to 440 Hz 180 to 250V ac, 47 to 440 Hz 11 to 15V dc, 40W (max)
CASE SIZE	20.45 cm W X 13.08 cm H X 32.69 cm L (8.05 in W X 5.15 in H X 12.85 in L)
PROTECTION CLASS	Class 1 (as relates solely to insulation or grounding properties further defined in IEC 348).
PRINTHEAD TEST	Prints all slash marks (/) if PAPER ADVANCE is pushed within one second of POWER ON.
REMOTE PRINT	Remote contact closure initiates print cycle.
PLOT MODE	With Options -001 and -003 only.

static awareness

A Message From

John Fluke Mfg. Co., Inc.

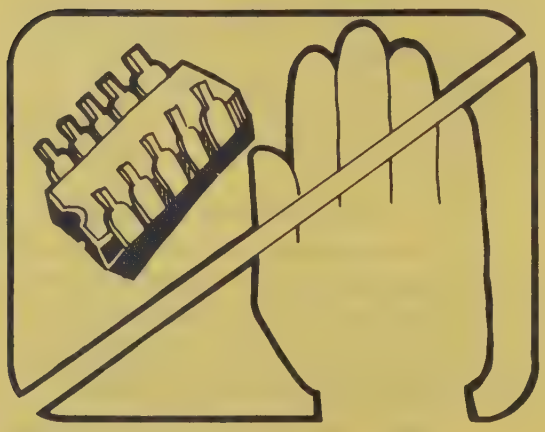


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

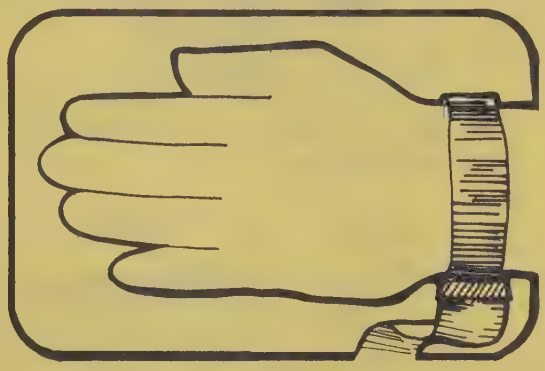
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

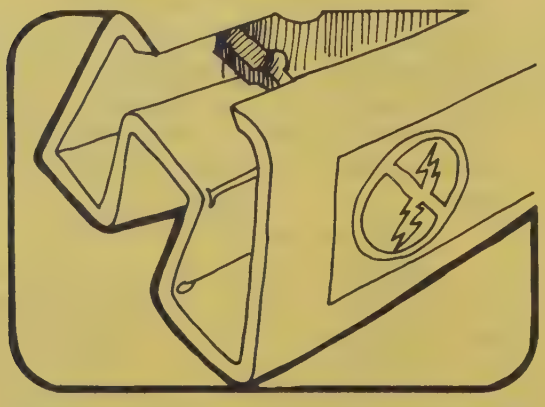
The following practices should be followed to minimize damage to S.S. devices.



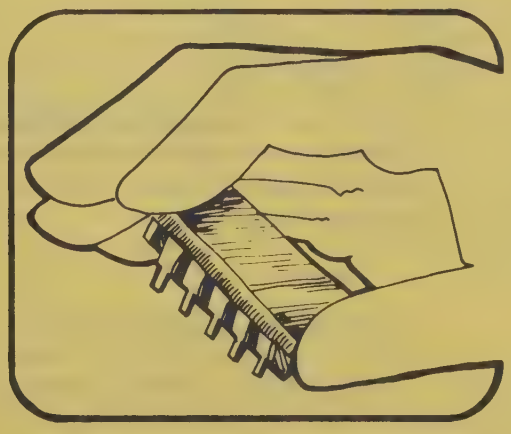
1. MINIMIZE HANDLING



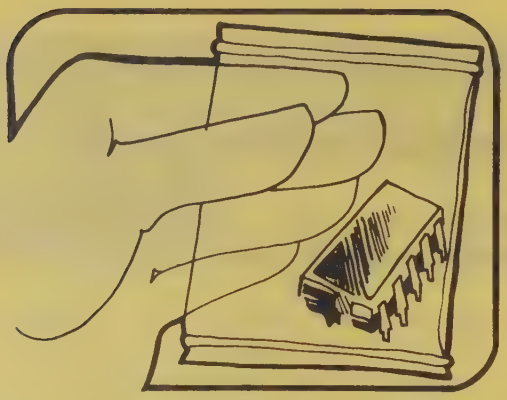
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



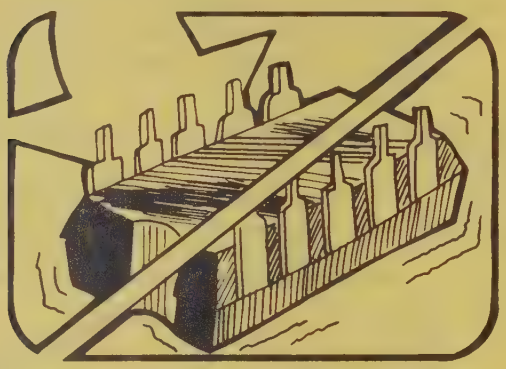
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



4. HANDLE S.S. DEVICES BY THE BODY

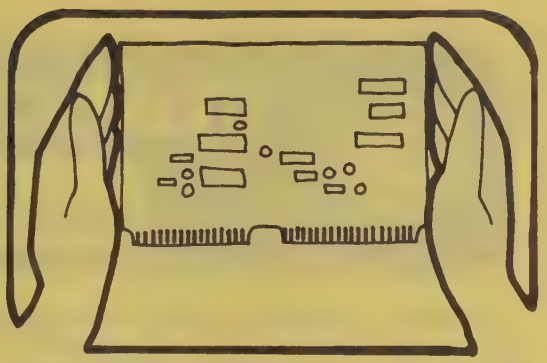


5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT

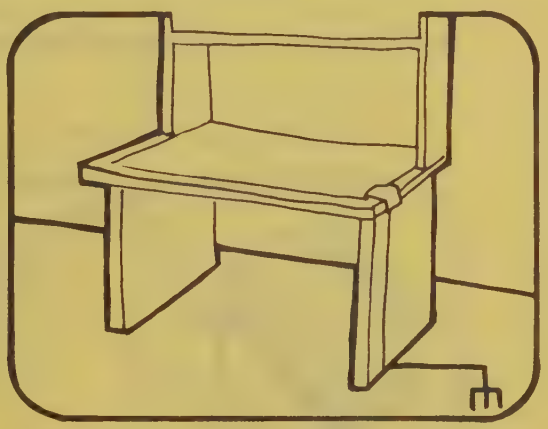


6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE

7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
453522	6" X 8" Bag
453530	8" X 12" Bag
453548	16" X 24" Bag
454025	12" X 15" Bag
Pink Poly Sheet 30"x60"x60 Mil P/N RC-AS-1200 $20.00	Wrist Strap P/N TL6-60 $7.00

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Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the 2020A Printer. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest Fluke Technical Service Center, or the John Fluke Mfg. Co., Inc.; P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of Technical Service Centers is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 2020A Printer is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The Model 2020A Printer requires one of three voltages for input power: 90 to 132V ac, 180 to 250V ac, or 11 to 15V dc. The ac input line voltage is switch selectable. Refer to Section 4 of this manual for instructions on verifying or changing the input line voltage switch setting. Input ac line voltage in either range must be between 47 and 440 Hz in frequency.

CAUTION

Before connecting the 2020A Printer to the local ac line, verify that the input voltage listed on the rear panel matches local line voltage.

2-8. The rear panel ac input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the applicable line voltage. The offset ground prong on this connector should be connected, through the power cord, to a high quality earth ground. The rear panel external 12V dc connector accepts two wires from an external supply. The two receptacles are marked for polarity.

2-9. INSTALLATION

2-10. Model 2020A Printer is packaged and installed in a PTI (Portable Test Instrument) case. The case is stackable, allowing the operator to fasten the printer and several accessories or Fluke test instruments together to form an easily transportable system. Maximum weight for one stacked-unit system is 40 pounds.

2-11. To prepare the 2020A Printer for operation, first verify that the internal input voltage select switch is in the correct position for the local line voltage. Refer to Section 4 of this manual for the correct procedure. Plug the input line power cord into the applicable power source or connect the 12V dc external input connector to an external 12V dc source. Connect the desired input test instrument to the printer through the rear panel connector. Refer to Section 6 for connector pin usage with each applicable interface option.

2-12. OPERATING FEATURES

2-13. Control and connector locations are shown in Figure 2-1; control and connector functions are described in Table 2-1. Interval Timer Option -006 control locations and functions are described in Section 6 in this manual.

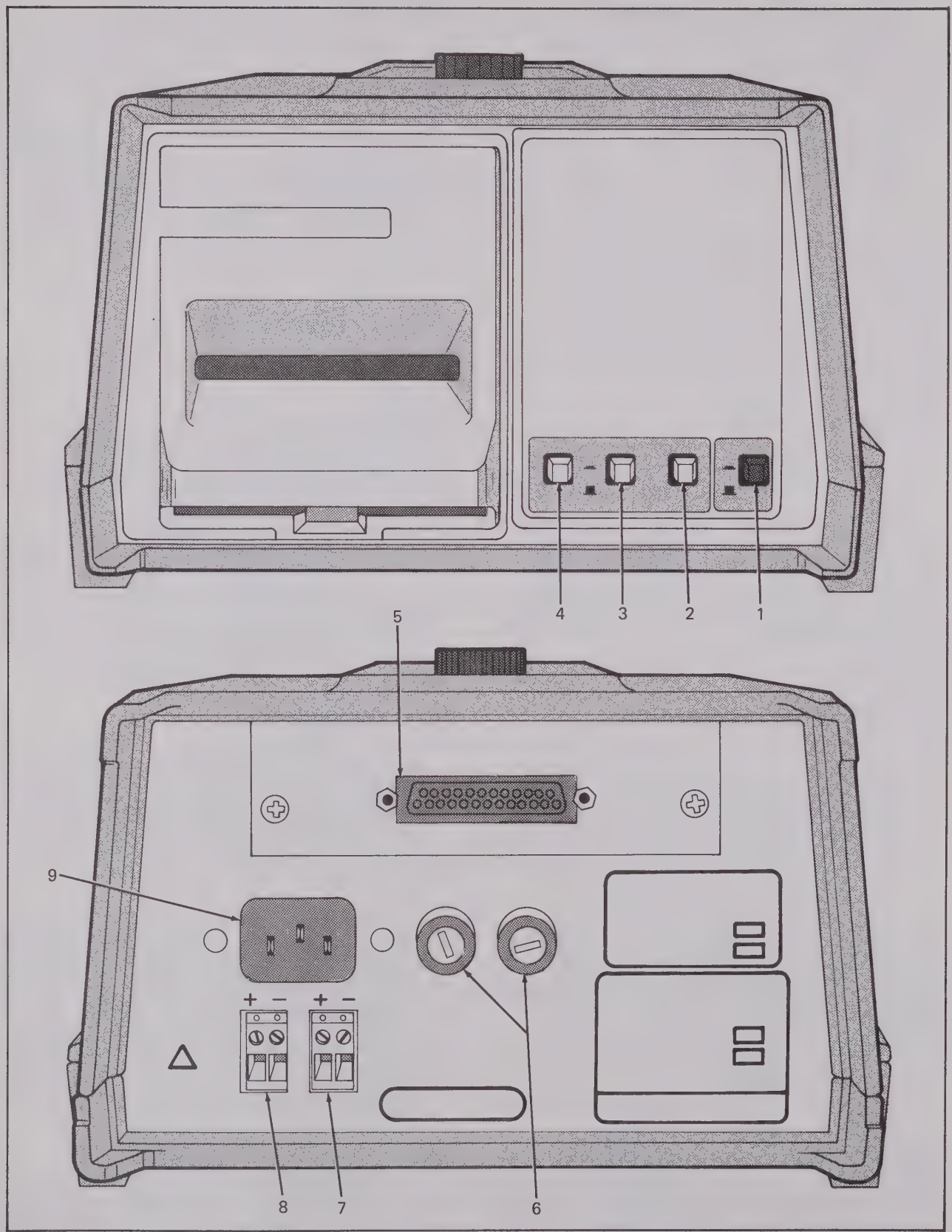


Figure 2-1. Control and Connector Locations

Table 2-1. Controls and Connectors

REF	CONTROL NAME	CONTROL FUNCTION
1	POWER	Applies power to, or removes power from instrument.
2	PAPER ADV	Advances printer paper.
3	CONT. PRINT	Initiates Continuous printing of input data.
4	SINGLE PRINT	Initiates Single Print of input data.
REF	**CONNECTOR NAME**	**CONNECTOR FUNCTION**
5	Data Connector	Connections for data transfer between input test instrument and printer.
6	Fuses	Fuses for input line power (F1) and 12V dc input voltage (F2).
7	Print Command	Input terminals for a remote single print switch.
8	DC Input Connector	Input terminals for external dc power source.
9	AC Line Connector	Power cord connection for ac line voltage.

2-14. One additional operating feature of the 2020A Printer is the remote print capability. A single print may be initiated from a remote input through the rear panel PRINT COMMAND connector. A momentary contact closure between the two connector pins initiates a single print of available input information. A maintained contact closure initiates continuous print cycles.

2-15. OPERATING NOTES

2-16. The following paragraphs describe various conditions that could effect printer operation. They also describe minor operator-performed, periodic service procedures. The operator should familiarize himself with these conditions and procedures prior to operating the 2020A Printer.

2-17. Option Information

2-18. Supplementary operating procedures may be necessary when operating a 2020A Printer equipped with some available options, or connected to some available accessories. Detailed information regarding the operation of each option and accessory is given in Section 6 of this manual, Option and Accessory Information.

2-19. Fuse Replacement

2-20. The ac line input and external dc input are individually fuse protected. Both fuses are readily accessible from the outside of the rear panel. The ac line input fuse (F1) should be replaced with a ½ amp slo-blo fuse if the 90 to 132 volt input range has been selected; use a ¼ slo-blo amp replacement if the 180 to 250 volt input range is in use. For the external dc input fuse (F2), use a 5 amp slo-blo replacement.

2-21. Paper Replacement

2-22. Paper used in the 2020A Printer is 2½ inches wide and is supplied in 240 foot rolls. The recommended paper type is 3M-162. It may be obtained for the John Fluke Mfg. Co. Inc., or from 3M Corporation. Use of other paper types may result in paper feed problems. Use the following procedure to install a new roll of paper:

1. Lift the latch located under the front of the printer unit cover to release it.

2. While holding the latch up, pull the printer out to the stop point.

3. Lift the empty cardboard roll and plastic dowel pin out of the printer chassis.

4. Place a fresh roll of paper on the dowel pin and reinstall the dowel pin and paper in the printer chassis.

5. Insert the beginning of the paper roll into the slot on the inside of the printer case front plate, and push the PAPER ADVANCE switch on the 2020A front panel to feed the paper through the printhead area.

2-23. OPERATING INSTRUCTIONS

2-24. Model 2020A Printers are available with five interface options and an Interval Print Option. The following operating instructions are valid with all interface options. Refer to Section 6 of this manual for Interval Timer Option operating instructions.

1. Prepare the 2020A Printer for operation by performing the installation procedures (refer to Installation instructions, in this section).

2. Press the POWER switch to supply input power to the printer circuitry.

NOTE

To initiate the printer self-test function, press the POWER switch then press PAPER ADVANCE within 1 second. The printer will produce a slash (/) in all digit columns if it is working properly.

3. To initiate a single information printout, push the SINGLE PRINT switch; to initiate continuous information printouts, press the CONT PRINT switch.

4. If remote operation is required, connect a switch closure input to the PRINT COMMAND connector on the printer rear panel. A single print can be initiated from a remote momentary switch; continuous printing requires a maintained contact closure.

5. For Interval Timer operating instructions, refer to Section 6, Interval Timer Option operating instructions.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description followed by a circuit analysis of the Model 2020A Printer. Simplified circuit diagrams are provided, as necessary, to supplement the text. Detailed schematics are available in Section 8 of this manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The 2020A is a thermal line printer designed to operate as a recording peripheral device for use with digital measurement instruments. It will record up to 20 characters per line. Five available interface options allow the printer to receive input information from a variety of digital instruments, including other Fluke instruments.

3-5. Functionally, the 2020A Printer may be separated into five sections as shown in Figure 3-1. Digital input signals from a measurement instrument enter the input interface board where they are processed and converted, as necessary, to produce digital information in the American Standard Code for Information Interchange (ASCII) format. Digital information, in ASCII, is transferred to the microcomputer control circuitry through a unidirectional bus. Under control of the resident program, the microcomputer control circuitry uses the information supplied to it to produce the required control signals for the voltage and current control circuitry. Voltage and current control circuitry switches power to the various printhead elements, in the order and at the time required, to produce thermally printed characters equivalent to the information displayed on the digital measurement instrument supplying the input. Power switched to the printhead elements is supplied by the +18V section of the power supply circuitry; power for the logic and control circuitry in the printer is supplied by the +5V power supply circuit.

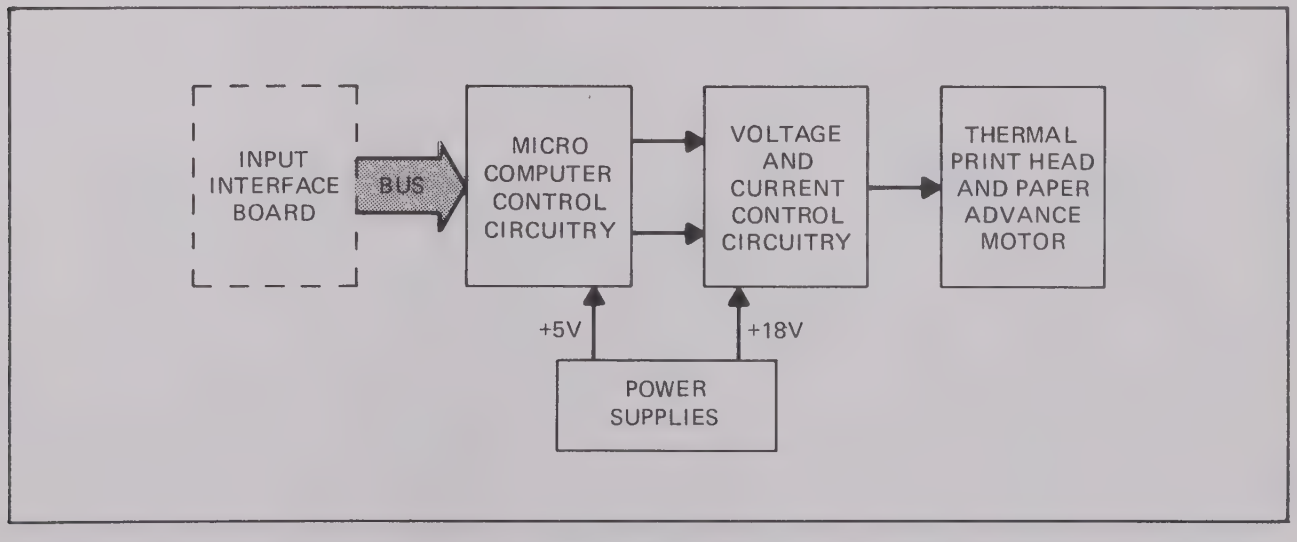


Figure 3-1. 2020A Printer Functional Sections

3-6. Five input interface options are available for use with the 2020A Printer. One of the options must be used with each printer. Options are available for the following input information formats: parallel ASCII, RS-232-C, IEEE-488, PTI, and parallel BCD. One additional option is available to allow operator programming for fixed interval printing. Refer to Section 6 of this manual for Interface and Interval Timer Option circuit theory.

3-7. Microcomputer Control Circuitry

3-8. Refer to Figure 3-2. Circuitry within the microcomputer control functional section includes a microcomputer, inverters, buffer drivers, and static shift registers. The microcomputer receives input information from the input interface option through the bus at Port 0. After the microcomputer internally deciphers and manipulates the data, it supplies data outputs to buffer driver circuits on lines 2 through 7 of Port 1, and to the static shift registers and inverters through data lines 0 through 3 of Port 2. Port 2, data lines 4 through 7, directly control four segments of a Darlington transistor array to drive the print motor and advance the paper. Output lines 0 and 1 of Port 1 communicate with the input interface option. Line 0 supplies an Acknowledge (ACK) signal indicating that data has been received. Line 1 of Port 1 supplies a signal (PRINTING) indicating that the printer is currently printing information received and cannot receive additional data. The microcomputer receives a Data Ready (DR) input from the input interface assembly. If the microcomputer is not, at present, printing previously received information, it responds with an Acknowledge (ACK) true signal to handshake data in. Although the microcomputer has received the data, it will not print that data unless the PRINT line is low when an ASCII Line Feed character, indicating the end of a data string, is handshaked in by the DR and ACK lines.

3-9. Microcomputer outputs from Port 1 and Port 2 are data inputs to the buffer drivers (Port 1, lines 2-7), inverters, and static shift registers (Port 2, lines 0-3). Port 2 (lines 4-7) also provides print motor control through four segments of an eight-segment Darlington transistor array.

3-10. Output line 2 of Port 1, through a buffer driver, controls a Darlington transistor which acts as an on-off switch for the positive 18 volt supply to the paper advance motor and dot selection Darlington transistors. Port 1 output lines 3 through 7, through buffer drivers, control five Darlington transistors to supply printhead Dot Select (DS) voltage.

NOTE

The Darlington transistor switch (controlled by Port 1, line 2) is turned on 1 second after power on and remains on until the 2020A is turned off.

3-11. Output lines 0 through 3 of Port 2, through inverters, control four segments of an eight-segment

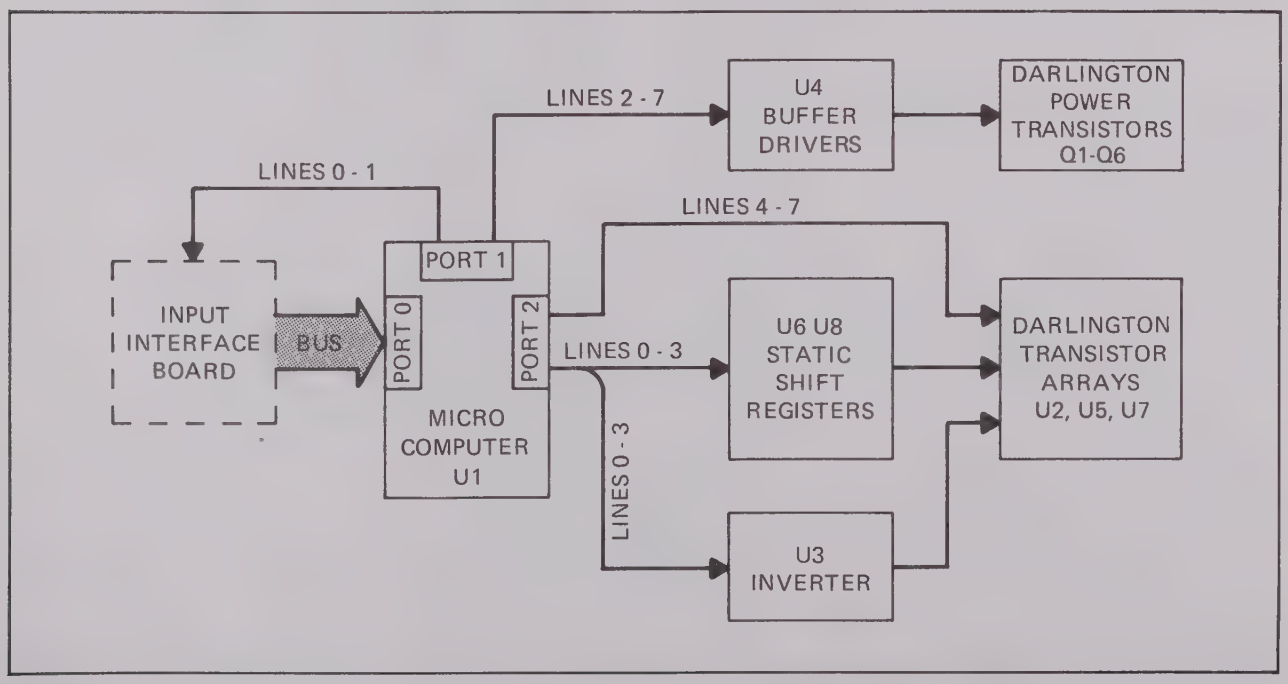


Figure 3-2. Simplified Block Diagram, Microcomputer Control Circuitry

Darlington transistor array to provide four Digit Enable (DE) inputs to the printhead. Port 2 data lines 0 through 3, also provide an additional 16 DE inputs to the printhead through two dual 4-bit static shift registers. The shift registers are used as an I/O expander for Port 2, data lines 0 through 3, allowing these four data lines to produce 16 control bits for 16 Darlington transistor segments in three Darlington transistor arrays. An output strobe from the microcomputer clocks the data bits in and out of the shift registers. The 20 control bits provided through the inverters, and shift registers control 20 Darlington transistor segments to produce 20 Digit Enable (DE) outputs for the printhead.

3-12. Voltage and Current Control

3-13. When the PRINT line is low, data read into the microcomputer is transformed into control data bits, and the control data bits are placed on Port 1 and Port 2 data lines. Port 1 data lines 3 through 7, through the buffer drivers, control five discrete Darlington power transistors. The power transistors switch power to five Dot Select (DS) bus lines on the thermal printhead. Refer to Figure 3-3. Each Dot Select Bus receives positive 18 volts from the power supply when the power transistors, at the direction of the microcomputer, supply that power.

3-14. As shown in Figure 3-3, corresponding print dots in all 20 printhead digits receive power when the bus that connects them receives power. Although all corresponding dots receive power, only those dots that also have a return path will be enabled. Return paths for print dot power are supplied through three, eight-segment Darlington transistor arrays, controlled by the microcomputer by way of the inverters and shift registers. These transistors are switched on and off individually to enable each digit in the printhead.

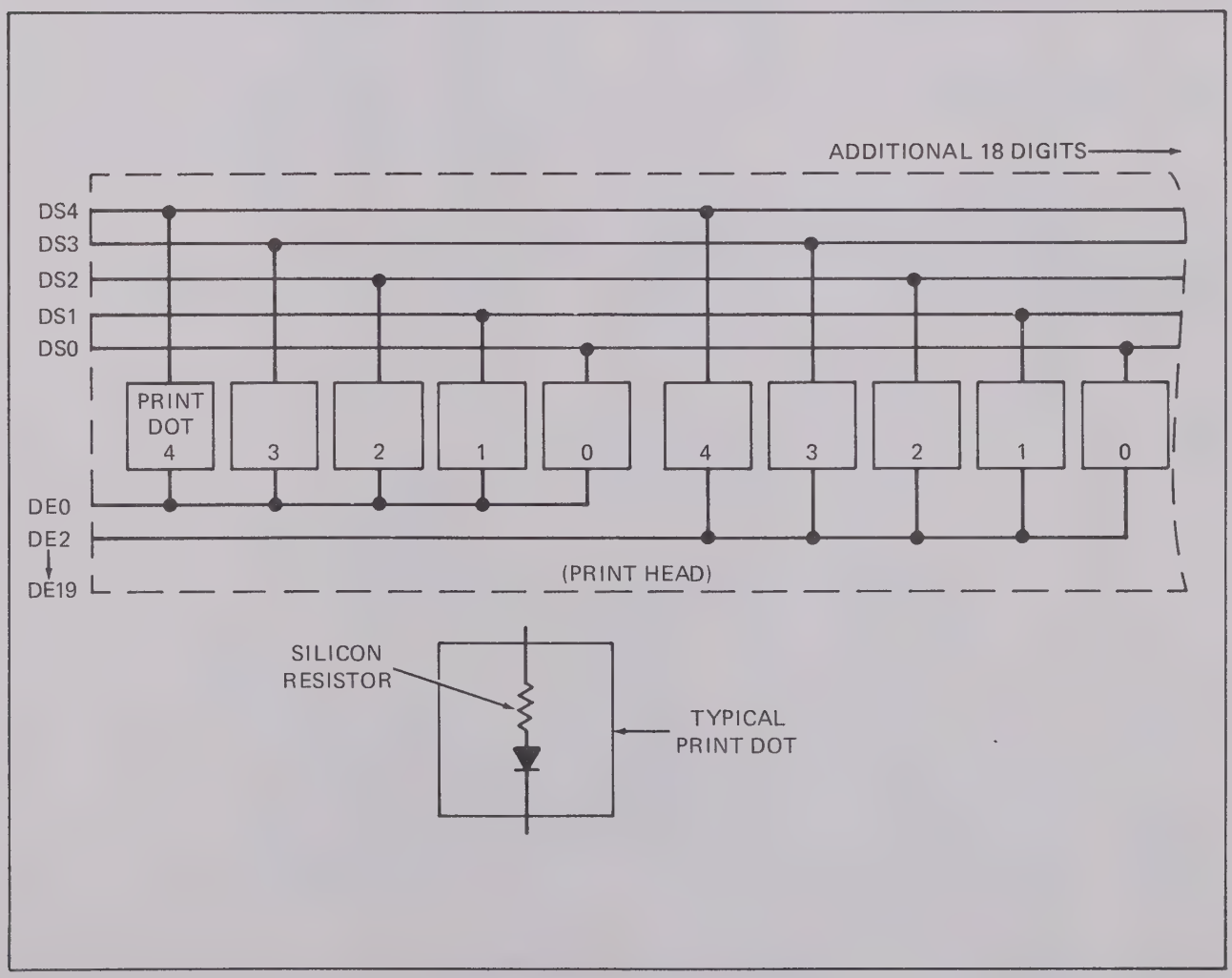


Figure 3-3. Printhead Configuration

3-15. Thermal Printhead and Paper Advance Motor

3-16. To produce an alphanumeric character, the printhead requires Dot Select inputs (one or more) and at least one Digit Enable input. These inputs allow one or more print dots to heat and, thereby, produce an impression on the printer paper. The characters are printed in a five column (horizontal) by seven row (vertical) dot matrix. Refer to Figure 3-4. The vertical matrix dimension is obtained by advancing the printer paper in precise steps. Port 2 data lines 4 through 7, from the microcomputer, control four segments of an eight-segment Darlington transistor array to provide return paths for power supplied through a discrete Darlington transistor controlled by Port 1, line 2, and one of five discrete Darlington transistors controlled by Port 1, lines 3 through 7. The return path Darlington transistors, controlled by Port 2, lines 4 through 7, are turned on and off in a microcomputer controlled sequence to achieve precise 7½° motor-rotation steps between print dot rows within the character matrix.

3-17. Power Supplies

3-18. Model 2020A print power supply circuitry may be viewed as two functional units; one unit supplies +5V dc to power the logic elements, and the other unit supplies +18V dc to power the thermal printhead and paper advance motor. A thermistor located near the thermal printhead regulates the +18V dc output to compensate for varying power requirements as the printhead warms and cools. This thermistor compensation maintains uniform character tones, or degree of darkness, through a wide range of ambient conditions.

3-19. The power supply section receives either ac or dc input power. The ac input power may be either 90 to 132 volts, or 180 to 250 volts, depending on the position of input power selector switch, S5. The dc power input must be +11 to +15 volts. If both +12V dc and an ac input are present, the power supply circuitry will operate from the ac supply. If the ac supply should fail, the power supply switches automatically to dc operation without interruption.

3-20. BLOCK DIAGRAM ANALYSIS

3-21. Microcomputer Input Sequence

3-22. Model 2020A Printer timing and control functions are performed by a single-chip, 8-bit microcomputer. It contains all necessary memory, programming, processing, timing, and I/O functions. One external component is required in the microcomputer circuit: a clock crystal to establish clock frequency. Refer to Figure 3-5, functional block diagram.

NOTE

Refer to Section 6 of this manual for applicable input interface option circuit theory.

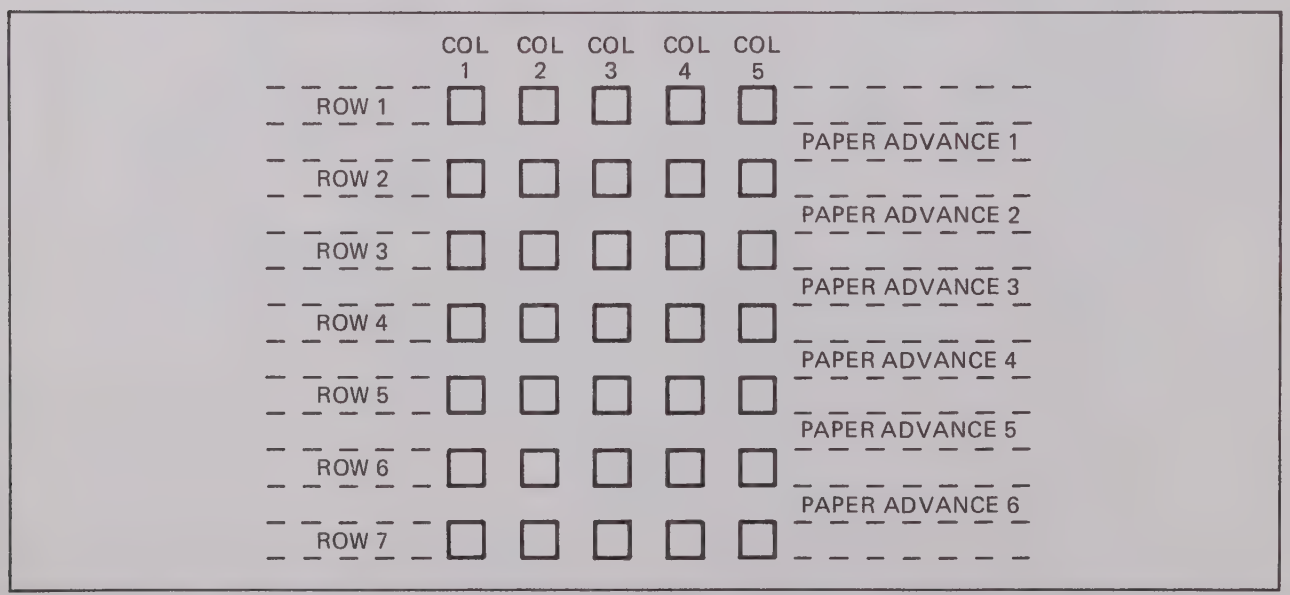


Figure 3-4. Alphanumeric Dot Matrix

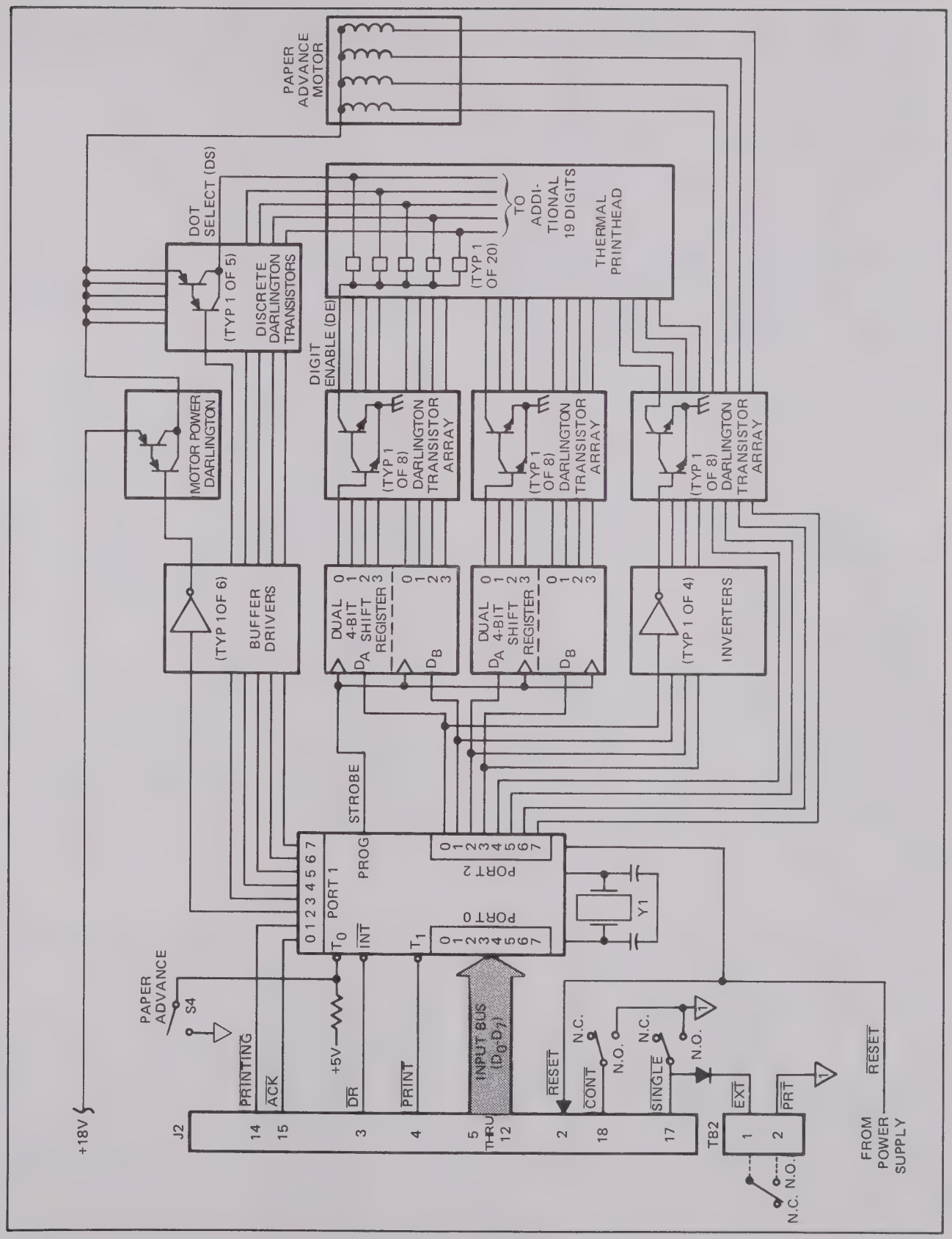


Figure 3-5. Printer PCB Block Diagram

3-23. When valid data is available on the Input Bus (Port 0, lines 0 through 7), the DR line will go to a low logic state (≤.7V) if the ACK signal (Port 1, line 0) is high (≥3.5V). If the PRINTING signal (Port 1, line 1) is also high, the microcomputer is ready to receive data. The Data Ready (DR) line will stay low until the Acknowledge (ACK) line is at a low logic state. The microcomputer acknowledges reading data by sending the ACK line to a low logic state. The ACK line will remain low for a short time after the DR line returns high.

3-24. If the PRINT line is at a low logic level when the microcomputer receives an ASCII Line Feed input (OA hex), the information received will be printed. An ASCII Line Feed input indicates the end of a data string. A low logic level PRINT command is generated through circuitry on the interface option from either a Single Print input, a Continuous Print input, Remote Print command, or an Interval Print input. The PRINT line must remain low 200 μs after ACK returns high.

NOTE

An Interval Print signal (INTP) is generated by the Interval Timer Option, and will not be available if the Interval Timer Option is not installed.

3-25. Microcomputer Output Sequence

3-26. The program resident in the microcomputer read-only-memory (ROM) directs internal data processing to produce microcomputer outputs representative of the input data. Data outputs from Port 1, lines 2 through 7, control power switching to the paper advance motor and printhead busses. Lines 0 through 3 of Port 2, through the shift registers and inverters, control the digit enable transistor arrays to provide return paths for printhead power. A microcomputer strobe, from the PROG line, strobes data from lines 0 through 3 of Port 2 into the shift registers. Lines 4 through 7 of Port 2 directly control return paths for the paper advance motor coils.

3-27. Paper Advance Motor Circuit

3-28. Microcomputer output line 2 of Port 1, controls power to the paper advance motor through a buffer driver and a discrete Darlington transistor. The buffer driver isolates the microcomputer from the Darlington transistor and provides sufficient signal strength to turn on the transistor. The motor power Darlington transistor, when it is switched on through the buffer driver, switches +18V dc (from the power supply) to four stepper motor coils, and to five additional Darlington transistors in the dot select circuit. Although +18V is present at one side of the motor coils, the motor will rotate only when power return paths are supplied through four segments of an eight-segment Darlington transistor array. The microcomputer turns on the return path transistors in a step sequence to rotate the paper advance motor in 7½° steps. The 7½° steps produce a seven-row dot matrix to print character lines. Refer to Figure 3-4. The operator can initiate a continuous paper advance by pressing switch S4. The switch supplies a low logic level at microcomputer input T0; the microcomputer then supplies a continuous sequence of signals to the motor power return transistor.

3-29. Dot Select Circuit

3-30. To produce a five column by seven row character dot matrix, the paper advance motor rotates 7½° for each dot row, and each printhead character contains five print dots. Print-dot power is available to the print dot Darlington transistors only when the +18V power transistor is on. Refer to Figure 3-6. Microcomputer

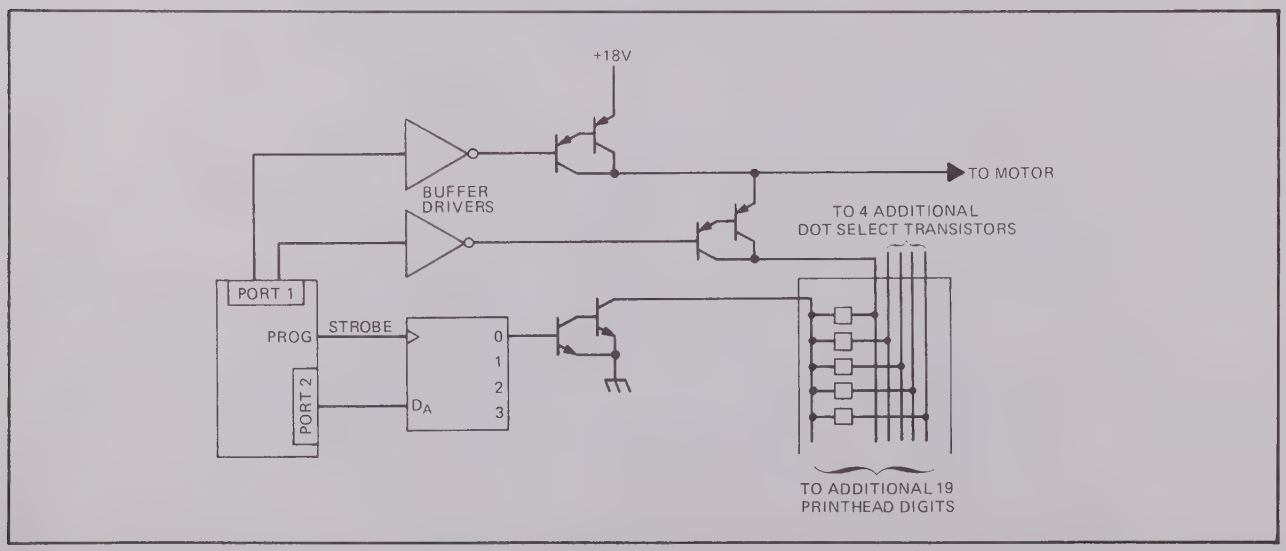


Figure 3-6. Simplified Dot Print Schematic

output signals on lines 3 through 7 of Port 1, through buffer drivers, switch five Darlington transistors on and off to supply +18V to the five printhead Print Dot Busses. Corresponding print dots in all 20 printhead digits are bussed, so they all receive power when the appropriate bus receives power. Only the print dots in a digit that has received a Digit Enable input will print. Refer to Figure 3-3.

3-31. Digit Enable Circuit

3-32. The Digit Enable circuit determines which digits of the 20 on the printhead will print a specific print dot when that Dot Bus receives power. Digit Enable and Dot Select inputs must be coincident for a dot to print.

3-33. Microcomputer Port 2, lines 0 through 3, controls and initiates Digit Enable commands. Lines 0 through 3 are inputs to four inverters and two dual 4-bit shift registers. Through the inverters, data outputs on lines 0 through 3 directly control four Darlington transistor segments of an eight-segment Darlington array to supply Digit Enable inputs to four of the 20 printhead digits. High logic levels from the microcomputer are inverted and applied to the Darlington transistor arrays. When a transistor segment conducts, it effectively supplies a common return on the Digit Enable (DE) line to that printhead digit. If +18V is available on any Print Dot Bus, current flow will produce heat in that print dot and the dot will produce an image on the paper. Digits 16, 17, 18, and 19 are controlled through the inverters and the Darlington transistor segments they control.

3-34. The remaining 16 digits on the 20-digit thermal printhead are also controlled by Port 2, lines 0 through 3, but the control signals are strobed through two dual 4-bit static shift registers. The shift registers are used as output bus expanders; they provide four output signals for each input line. A strobe pulse from the microcomputer provides clocked (synchronous) shift register operation.

3-35. Data from the microcomputer is transferred into the shift registers in a serial manner; each bit of input data is shifted from one stage to the next during the positive-going strobe pulse transition. One data bit in, then, may enable any of four different digits, depending upon its position in the shift register.

3-36. A shift register output enables 1 of 16 Darlington transistor circuits; the enabled Darlington circuit supplies power common to 1 of 16 digit segments on the printhead. The remaining four printhead digit segments are controlled through the inverters and four additional Darlington transistor circuits.

3-37. Power Supply

3-38. POSITIVE 5 VOLT POWER SUPPLY

3-39. Line ac voltage, through connector J11 and fuse F1, is switched (S1) to an ac power transformer (T1). An additional switch (S5), provides input voltage range selection, either 90 to 132V ac, or 180 to 250V ac. The ac input is bridge rectified, then filtered to supply a dc input to both the +5 volt supply and the +18 volt power supply circuitry. Direct dc power may be supplied through a rear panel connector. The dc input power is fused, switched, and supplied to the same point as the rectified and filtered ac input. The dc input voltage range is from positive 11 to 15 volts dc; and the input dc supply must be capable of supplying 8 amps peak current for 2 ms of each 8 ms during a print cycle. Refer to Figure 3-7, Simplified Power Supply Block Diagram.

3-40. Refer to Figure 3-8, +5 Volt Power Supply Simplified Schematic. Input voltage VA (supplied

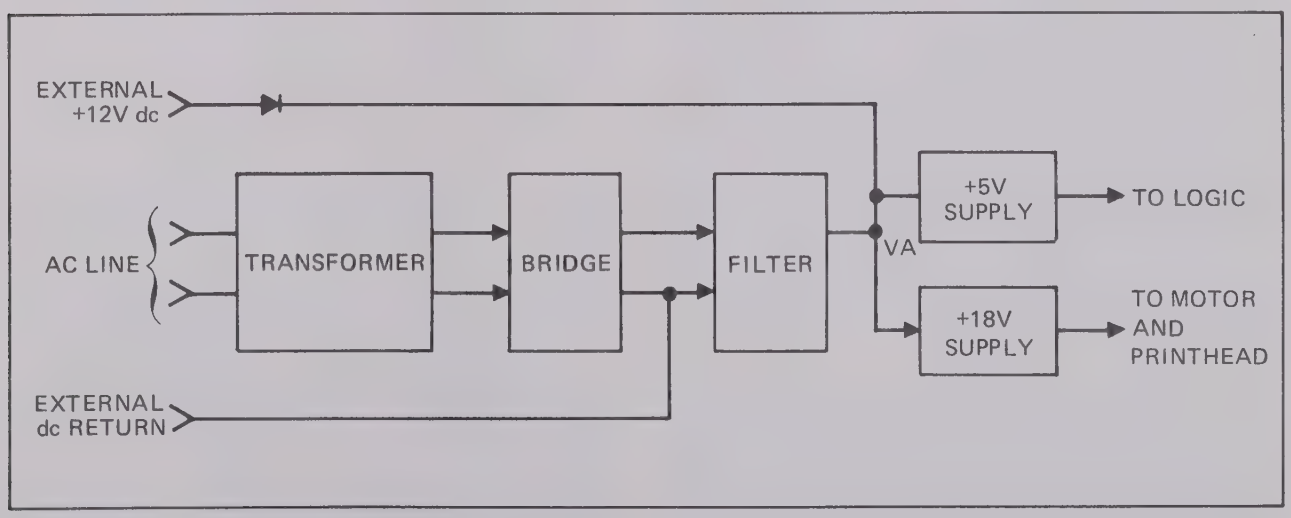


Figure 3-7. Simplified Power Supply Block Diagram

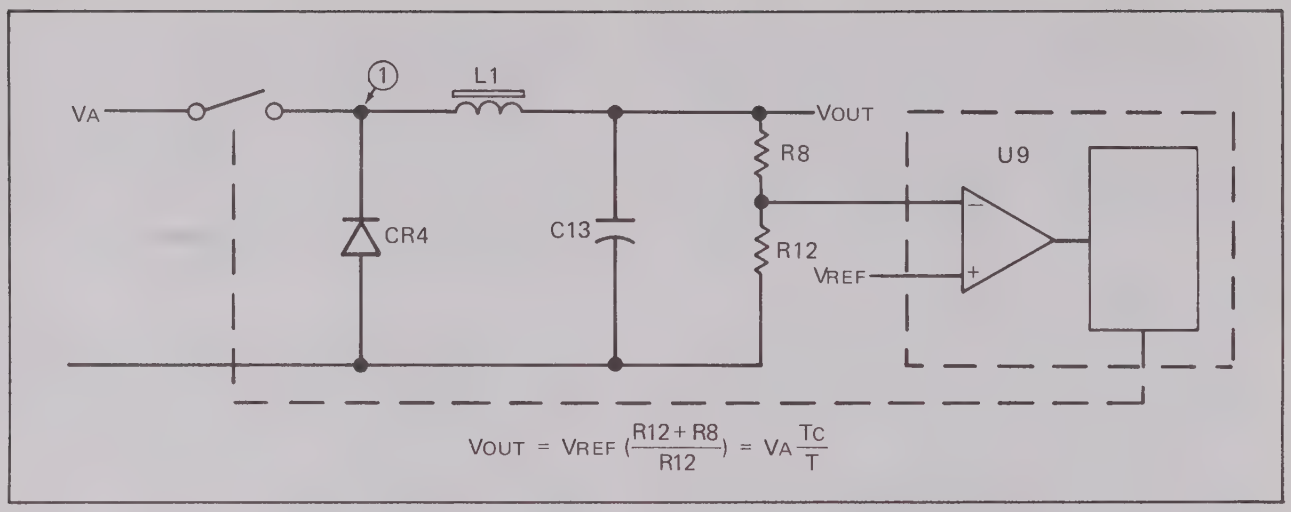


Figure 3-8. Positive 5 Volt Power Supply Simplified Block Diagram

through the transformer, bridge, and filter, or directly through the dc input and switch) goes to a switch circuit in the +5 volt power supply. The switch circuit is composed of two transistors (Q7, Q8) and associated circuitry. A pulse width modulator (PWM) control chip (U9), a filter, and a voltage divider network form the remainder of the +5 volt power supply circuit.

3-41. Voltage out of the switch circuit, through the filter, is scaled by the voltage divider network (R8, R12) and supplied as an input to an error amplifier within the PWM chip (U9). The error amplifier compares the scaled output voltage to a fixed reference voltage (2.5V) and produces an output representative of the difference. Error amplifier output controls the pulse width modulator, which in turn, controls the amount of time the switch circuit remains on.

3-42. Refer to Figure 3-9, +5 Volt Power Supply Typical Switch Circuit Times. Voltage out (Vout) is the average value of the square wave produced at the switch circuit output (Figure 3-8, point 1). Total time (T) is fixed at approximately 25 μs by the pulse width modulator circuit frequency. As the error amplifier detects a rise in Vout, compared to Vref, the error amplifier output decreases, decreasing the percentage of total time (T) the PWM keeps the switch circuit on (Tc). This lowers the percentage of time (T) that voltage in (VA) is allowed to pass, thus lowering the average voltage out (Vout). This relationship may be expressed mathematically as: Vout = VA Tc/T.

3-43. As indicated by both the formula and Figure 3-9, a wide range of input voltages (VA) can be regulated to positive 5 volts by varying the percentage of total time (T) that the switch circuit remains on (Tc). A dc average of the switch circuit square wave is obtained through the filtering provided by coil L1 and capacitor C13.

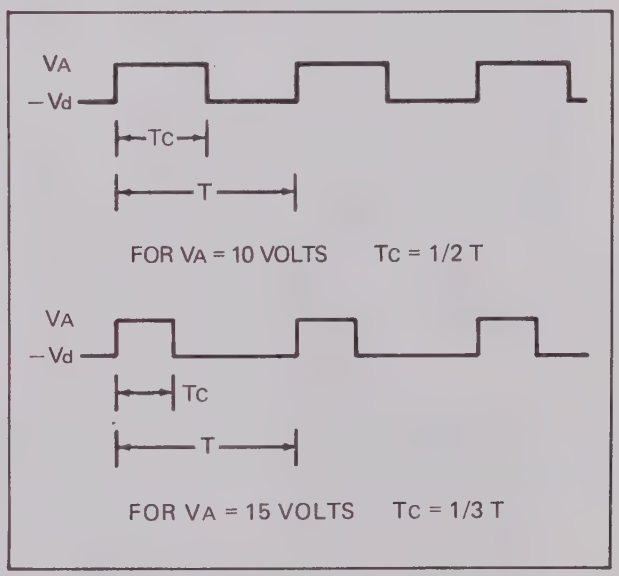


Figure 3-9. Positive 5 Volt Power Supply, Typical Switch Circuit Times

3-44. POSITIVE 18 VOLT POWER SUPPLY

3-45. The positive 18 volt power supply is a step-up, pulse width modulated regulator. Input voltage (VA) is stepped-up and regulated at 18 volts through an error amplifier, comparator, switch circuit, coil, and capacitor. Two inputs are required in addition to input voltage: reference voltage (Vref) and a +1.5 to +3.5 volt sawtooth waveform. Reference voltage is supplied by the reference voltage regulator (U10) and the sawtooth waveform is supplied by the 5 volt power supply pulse width modulator (U9).

3-46. Refer to the Positive 18 Volt Power Supply Simplified Schematic, Figure 3-10. Assuming that the

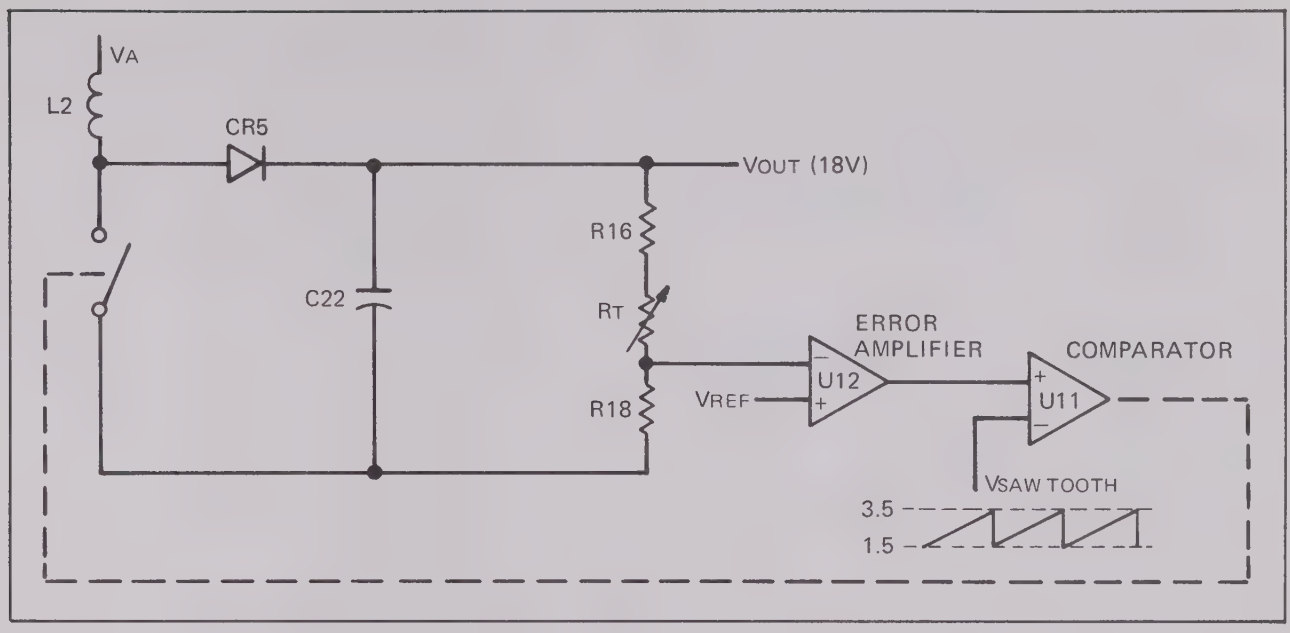


Figure 3-10. Positive 18 Volt Power Supply Simplified Schematic

output voltage (Vout) has decreased below the desired level, the error amplifier output, due to the increased difference between the scaled Vout input and the reference voltage, will become more positive. As the error voltage into the comparator becomes more positive, the comparator output will remain cutoff longer because the sawtooth waveform must increase to a higher level before an output is produced. A longer period with no output from the comparator allows the switch circuit (Q10, Q11) to remain on longer, thus allowing inductor L1 to store more energy. While the switch circuit is on, output power is supplied by capacitor C22. When the comparator turns off the switch circuit, the collapsing field around L1 releases energy which is stored in capacitor C22, and supplied to the load. (Refer to Figure 3-11 for typical waveforms.)

3-47. Output voltage may be calculated using the formula Vout = Va (1 + Tc/To), where Tc is the time the switch is on and To is the time the switch is off. Vout may also be calculated as follows:

$$\text{Vout} = \text{Vref}\left[1 + \frac{(\text{R16} + \text{RT})}{\text{R18}}\right]$$

Energy stored in inductor L2 is $E = \frac{L\,Ip}{2}$, where $Ip = \frac{VA\,Tc}{L2}$

3-48. In the voltage divider resistor string which supplies input voltage to the comparator (U12), RT is shown as a variable resistor. The variation in total resistance is induced by a thermistor mounted on the thermal printhead. Printhead temperature varies due to many operating conditions, including the number of characters printed per line, and the selected print mode (single or continuous). The thermistor, connected in parallel with a fixed resistor in the voltage divider string, varies with temperature, thus, varying the input voltage to the comparator. As a result, output voltage decreases as printhead temperature increases, thus, maintaining uniform print character darkness or density.

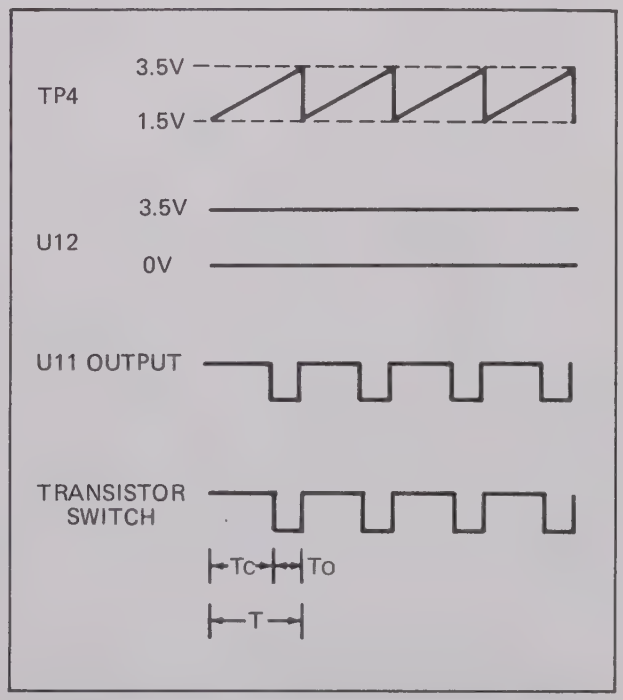


Figure 3-11. Power Supply Waveforms

3-49. POWER SUPPLY PROTECTION

3-50. Three circuits in the power supply provide circuit protection. Two low voltage protection circuits are present; one resets the microcomputer if the supply voltage (VA) goes below 8.6V dc, and the other resets the microcomputer if the positive 5V dc output falls below positive 4V dc. A current limit circuit protects the positive 5V dc power supply section.

3-51. Low voltage protection is provided by two comparator circuits, each circuit utilizing one-half of a dual comparator IC (U13). Comparator U13A compares a scaled portion of the input voltage (VA) to a 2.5V reference voltage. If input voltage drops below 8.57V dc, the comparator positive input drops below the reference voltage, and comparator output goes to a low logic level, initiating a reset to the microcomputer. The microcomputer then turns off the 18 volt supply to the motor and printhead. Comparator circuit U13B monitors the positive 5 volt supply in the same fashion, and issues a microcomputer reset in the same manner, with the same result.

3-52. Positive 5 volt power supply current is limited to approximately 1 ampere. A transistor (Q9) and three parallel resistors (R5, R6, R7) perform the current limiting function. A current of 1 ampere through the parallel resistors results in a .5V dc voltage drop. This voltage drop turns on the transistor, which sources current to the shutdown circuitry within the pulse width modulator (U9). Pulse width modulator duty cycle decreases, thereby lowering the output voltage but maintaining a constant current. If the positive 5 volt output falls below 4 volts, the low voltage limit circuit resets the microcomputer.

3-53. PROGRAM FUNCTIONS

3-54. Programming resident in the microcomputer controls all major printer functions; i.e., the input sequence, print cycle, and plot mode operation.

3-55. Printer input is an ASCII string which consists of 20 ASCII characters. Each character is read-in using a handshake mode under firmware control. The input character string is terminated by an ASCII Line Feed input, and any character beyond the twentieth character, except a Line Feed, is deleted. An ASCII Form Feed control character advances the printer paper to the next print line. Refer to Table 3-1. Valid ASCII characters for the printer are the standard 64-character ASCII set, plus special characters shown in the table.

3-56. Programming controls the printhead and motor electronics to print the character represented by the input ASCII code. It also initiates a print cycle when the SINGLE PRINT or CONTINUOUS PRINT switch is pushed, and it advances the paper when the PAPER ADVANCE switch is pushed. Firmware controls binary dot positions in plot mode operation.

Table 3-1. 2020A Valid Characters

CODE	CHAR	CODE	CHAR
32		69	E
33	!	70	F
34	"	71	G
35	#	72	H
36	$	73	I
37	%	74	J
38	&	75	K
39	'	76	L
40	(	77	M
41	)	78	N
42	*	79	O
43	+	80	P
44	,	81	Q
45	-	82	R
46	.	83	S
47	/	84	T
48	0	85	U
49	1	86	V
50	2	87	W
51	3	88	X
52	4	89	Y
53	5	90	Z
54	6	91	[
55	7	92	\
56	8	93	]
57	9	94	^
58	:	95	_
59	;	100	`
60	<	102	f
61	=	107	k
62	>	109	m
63	?	110	n
64	@	112	p
65	A	114	q
66	B	115	s
67	C	117	x
68	D	122	z

3-57. Plot mode operation is initiated by an ASCII code Control P (hex 10). The printer reads in, in the handshake mode, up to 20 binary values, not including the binary dot string terminator. The binary dot string is terminated by a binary value equal to decimal 255 (hex FF). Legal binary dot positions equal decimal 0 through decimal 99, with decimal 0 printing on the left side of the paper and decimal 99 printing on the right. A binary value equal to decimal 254 (hex FE) initiates a paper advance to the next dot-row position.

3-58. Firmware programming initiates and controls a print cycle upon receipt of a PRINT command. As shown in Figure 3-12, a print cycle consists of seven dot-strobe cycles followed by three paper advances. Figure 3-13 represents a typical dot-strobe cycle. During each dot-strobe cycle, each Dot Select Bus receives power in sequence. If a particular digit is enabled during the time a Dot Select Bus receives power, that print dot in that digit will print. When all Dot Select Bus lines have been strobed, the paper is advanced one step and the dot-strobe cycle is repeated. After seven dot-strobe cycles, an additional three paper advance pulses are produced to provide a space between print lines. The fourth paper advance shown in Figure 3-12 is the paper advance that follows every dot-strobe cycle.

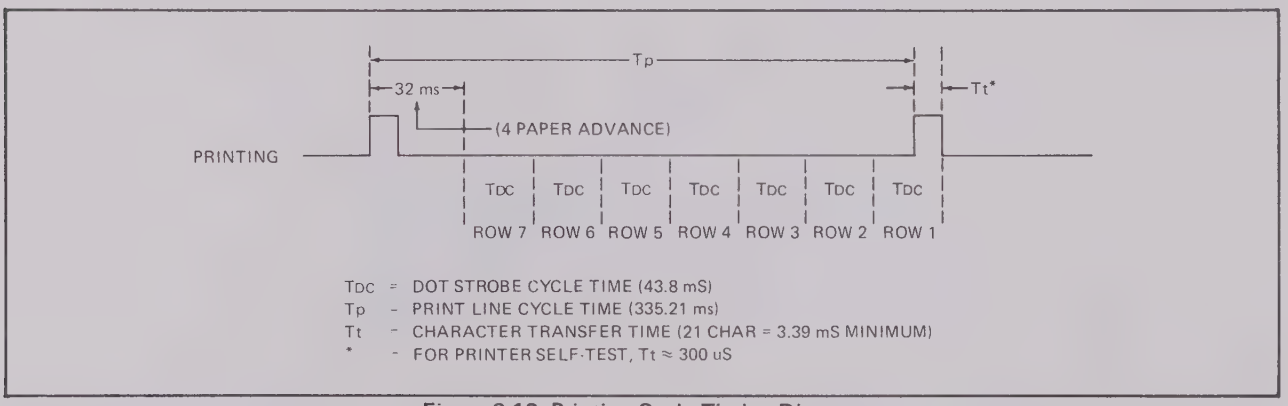

Tp
32 ms
Tt*
(4 PAPER ADVANCE)
PRINTING
TDC TDC TDC TDC TDC TDC TDC
ROW 7 ROW 6 ROW 5 ROW 4 ROW 3 ROW 2 ROW 1
TDC = DOT STROBE CYCLE TIME (43.8 mS)
Tp - PRINT LINE CYCLE TIME (335.21 ms)
Tt - CHARACTER TRANSFER TIME (21 CHAR = 3.39 mS MINIMUM)
* - FOR PRINTER SELF-TEST, Tt ≈ 300 uS

Figure 3-12. Printing Cycle Timing Diagram

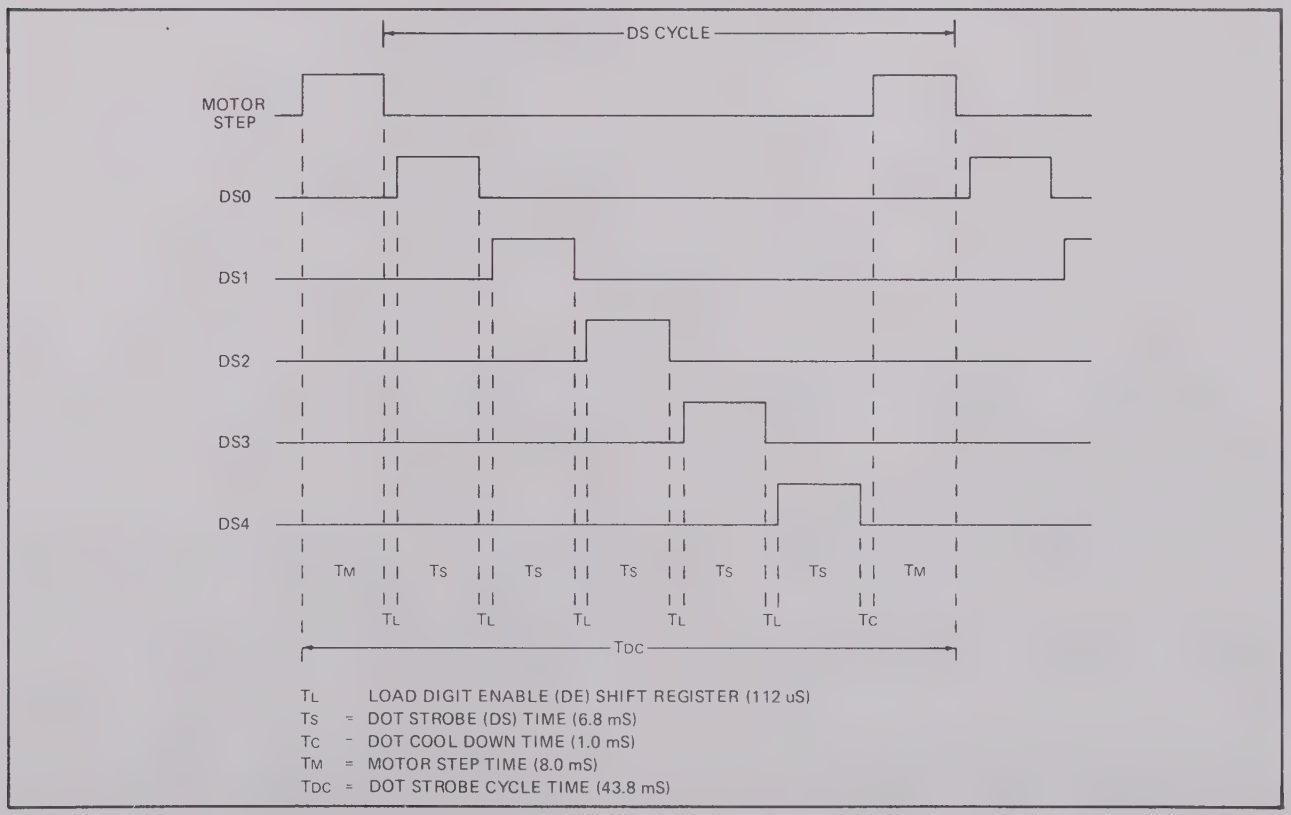

DS CYCLE
MOTOR STEP
DS0
DS1
DS2
DS3
DS4
TM TS TS TS TS TS TM
TL TL TL TL TL TC
TDC
TL LOAD DIGIT ENABLE (DE) SHIFT REGISTER (112 uS)
TS = DOT STROBE (DS) TIME (6.8 mS)
TC - DOT COOL DOWN TIME (1.0 mS)
TM = MOTOR STEP TIME (8.0 mS)
TDC = DOT STROBE CYCLE TIME (43.8 mS)

Figure 3-13. Dot Strobe Cycle Timing Diagram

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual provides information about warranty, factory service, maintenance, performance testing, routine calibration adjustments and repair. The performance test is recommended as an acceptance test when the unit is first received, and later as a calibration procedure to verify the instrument specifications given in Section 1. A printer self-test feature is standard; it should be performed each time the printer is turned on.

4-3. SERVICE INFORMATION

4-4. The Model 2020A Printer is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page located in the front of this manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before any work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Instrument Disassembly

4-8. Removing the printer from its case is only necessary for maintenance. Disassemble the printer using the following procedure:

1. Disconnect all power cords and input cables.

2. Remove the four screws in the bottom of the case that secure the cover.

3. Lift the cover clear of the unit by pulling straight up.

NOTE

Steps a through c are necessary only if the 2020A Printer is equipped with Interval Timer Option -006.

a. Remove the two screws holding the Interval Timer PCB to the interface pcb and pull the back edge of the Interval PCB up to disconnect it from the interface pcb.

b. Pull the Interval PCB toward the rear of the 2020A Printer to disconnect it from the Keyboard PCB.

c. Remove the Keyboard PCB by releasing the clips that hold it to the front panel.

4. Remove the single screw at the front of the

interface pcb, and the two screws securing the connector to the rear panel.

5. Disconnect the ribbon cable between the interface pcb and the Printer PCB, then remove the interface pcb.

6. Remove two screws, one near the center of the Printer PCB and one centered near the front edge, and lift the Printer PCB and rear panel out of the case bottom.

7. Disconnect the ribbon cable between the printhead chassis and the Printer PCB and slide the printhead chassis forward to remove it.

8. Remove the front panel by lifting it clear of the slot in the case and tilting it to clear the front panel switches.

9. To reassemble the 2020A, logically reverse the preceding steps.

4-9. Fuse Replacement

WARNING

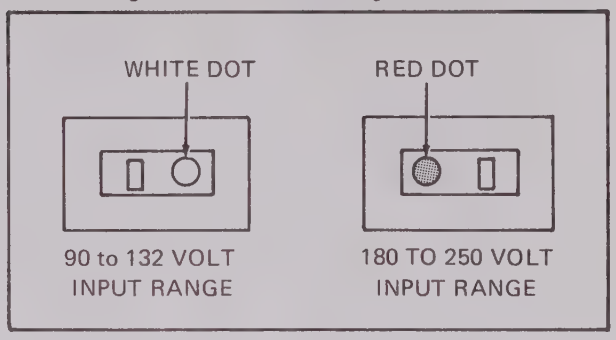
DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACEMENT.

4-10. The ac line input and external dc input are individually fuse protected. Both fuses are readily accessible from the outside of the rear panel. To replace a fuse, insert a screwdriver in the grey fuse cap, push the cap slightly and rotate it ¼ turn counterclockwise. Remove the fuse cap, replace the fuse, and reinstall the fuse cap. The ac line input fuse (F1) should be replaced with a ½ amp slo-blo fuse of 90 to 132 volt input range is in use; use a ¼ amp slo-blo replacement fuse if the 180 to 250 volt input range is in use. The external dc input fuse (F2) requires a 5 amp slo-blo replacement.

4-11. Line Voltage Selection

4-12. Two ac line input voltage ranges are switch selectable in the 2020A Printer: 90-132 volts and 180-250 volts. The position of the line voltage select switch (S5), determines the acceptable line voltage. To check or change the line voltage select switch position, remove the top cover from the 2020A case. (Refer to Instrument Disassembly.) Switch S5 is located at the right rear corner of the Printer PCB, as viewed from the front. Move the switch slide toward the front panel, exposing the white dot, for 90 to 132 volt input line operation. Refer to Figure 4-1.

Figure 4-1. AC Line Voltage Selection



4-13. Cleaning

4-14. Clean the instrument periodically to remove dust, grease, and other contamination. Use the following procedure:

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They may damage plastic materials used in the instrument.

1. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.

2. Clean pcb surfaces using clean, dry air at low pressure (≤20 psi).

3. If grease is encountered, spray with anhydrous alcohol and remove grime with clean, dry air at low pressure.

4-15. PERFORMANCE TEST

4-16. Performance testing of the Model 2020A Printer circuitry is performed by initiating a programmed self-test function. To initiate the printer self-test, push the PAPER ADVANCE switch within 1 second after pushing the POWER switch. If all printer circuitry is functioning properly, the printer will produce a slash mark (/) in each digit column and continue to produce them until the PAPER ADVANCE switch is released. If the printer does not produce slash marks in all 20-digit columns, refer to the troubleshooting procedures, Table 4-1.

4-17. The printer self-test program tests the 2020A Printer PCB circuitry, power supplies, and the printhead and paper advance motor. It does not test the Interface Option PCB or the Interval Timer Option. Performance tests for these options may be found in the applicable part of Section 6.

4-18. CALIBRATION ADJUSTMENT

4-19. Model 2020A Printer circuitry does not require calibration adjustment. However, certain input interface options and the Interval Timer Option do require adjustments. Refer to the applicable portions of Section 6, Option and Accessory Information.

4-20. TROUBLESHOOTING

4-21. Troubleshooting information presented in Tables 4-1 through 4-5, is intended as a guide to assist in isolating a malfunction to the component level. Table 4-1 provides a guide to determining which functional circuit section is defective; each of the remaining four tables provide a guide to isolating the defective component within that specific functional circuit section. The tables are arranged in a tabular flow chart format. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision transfer is required, perform the next step on the table in sequence.

Table 4-1. Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Are both power supply outputs present and correct?	2	8
2	Did all digits print?	3	5
3	Did all dots in all digits print?	4	6
4	Did the Paper Advance Motor function correctly?	9	7
5	Consult Table 4-2.		
6	Consult Table 4-3.		
7	Consult Table 4-4.		
8	Consult Table 4-5.		
9	Consult applicable Option and Accessory Troubleshooting tables in Section 6.		

Table 4-2. Digit Enable Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Remove the printer case. (See Instrument Disassembly).		
2	Is the Digit Enable command present at the applicable output of U2, U5 or U7? (Refer to schematic, Section 8).	3	4
3	Repair or replace the printhead.		
4	Is the Digit Enable command present at the output of either the shift registers or inverters?	5	6
5	Check the appropriate Darlington array (U2, U5 or U7).		
6	Are Digit Enable commands present at microcomputer output pins 21, 22, 23 and 24?	7	9
7	Is a strobe signal present at microcomputer output pin 25?	8	9
8	Check the appropriate shift register or the inverter.		
9	Is microcomputer input line 1 (Port 1) low and line 28 low with a ≈300 μs pulse, spaced at ≈331 ms?	10	11
10	Check the microcomputer.		
11	Consult the appropriate Input Interface Option troubleshooting procedure in Section 6.		

Table 4-3. Dot Select Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Did the same dot or dots in all digits fail to print?	3	2
2	Check the printhead.		
3	Did all dots fail to print?	12	4
4	Is +16 to +18 volts present at the output of the applicable transistor (Q2, Q3, Q4, Q5, or Q6)?	5	6
5	Check the connectors and cable between the Printer PCB and printer chassis. Also check the printhead.		
6	Are Dot Select commands present at the output of the appropriate buffer driver?	7	8
7	Check the appropriate Darlington transistor (Q3, Q3, Q4, Q5, or Q6).		
8	Are Dot Select commands present at the applicable output of the microcomputer?	9	10
9	Check the appropriate buffer driver.		
10	Are microcomputer input lines 1 and 28 low, with a positive ≈300 μs pulse, spaced ≈335 ms on line 28?	11	15
11	Check the microcomputer.		
12	Is positive 16 to 18 volts present at the output of Darlington transistor Q1?	14	13
13	Refer to Table 4-4, Motor Circuit Troubleshooting Guide.		
14	Check circuit path between Q1 output and Q2-Q6 inputs.		
15	Consult the appropriate Input Interface Option troubleshooting procedure in Section 6.		

Table 4-4. Motor Circuit Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Did the Paper Advance Motor fail completely?	2	12
2	Is +16 to +18V dc present at the output of transistor Q1?	3	4
3	Check the motor and all lines and connections from the Printer PCB to the motor.		
4	Is +16 to +18V dc present at the input to transistor Q1?	6	5
5	Refer to Table 4-5, Power Supply Troubleshooting Guide.		
6	Is a motor power command present at the base of Q1?	7	8
7	Check transistor Q1.		
8	Is a motor power command present at the buffer driver input?	9	10
9	Check the buffer driver.		
10	Is the microcomputer supplying motor power commands?	12	11
11	Troubleshoot the microcomputer and associated components.		
12	Are motor enable commands present at pins 15, 16, 17, and 18 of transistor array U2?	13	14
13	Are the motor enable commands constantly changing logic states?	3	14
14	Are constantly changing motor commands being supplied on microcomputer pins 35, 36, 37, and 38?	15	11
15	Motor circuit troubleshooting is complete.		

Table 4-5. Power Supply Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Is positive 5V dc present at TP2?	2	9(3)
2	Is positive 18V dc present at TP3?	11	10(3)
3	Are both output voltages absent?	4	9;10
4	Check fuses F1 and F2.		
5	Check switch S5 for proper position.		
6	Is voltage VA present? (+ side of C8).	8	7
7	Check the input transformer, bridge rectifier, and regulating diode.		
8	Check the Pulse Width Modulator and Reference Voltage Regulator (TP4 - see Figure 3-11.)		
9	Check +5V power supply circuit. Refer to Section 3, and to Figures 3-8 and 3-9.		
10	Check +18V power supply circuit. Refer to Section 3, and to Figures 3-10 and 3-11.		
11	Power Supply troubleshooting is complete. Disconnect all test equipment.		

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NAME	DRAWING NO.	TABLE NO	TABLE PAGE	FIGURE NO.	FIGURE PAGE
Final Assembly, Model 2020A	2020A-T&B/4201	5-1	5-3	5-1	5-4
A1 Printer Main PCB Assembly	2030A-4001	5-2	5-6	5-2	5-9
A2 Printer Mechanism Assembly	2030A-4202	5-3	5-10	5-3	5-11
A2A1 Printer Interconnect Assembly	2030A-4004	5-4	5-12	5-4	5-12

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the Options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.

2. Description of each part.

3. FLUKE Stock Number.

4. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)

5. Manufacturer's Part Number.

6. Total Quantity of components per assembly.

7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of 2 years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for 1 year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked (see paragraph 5-7). In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended spares quantity for the items in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. or authorized its representatives by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.

2. FLUKE Stock Number.

3. Description.

4. Reference Designation.

5. Printed Circuit Board Part Number and Revision Letter.

6. Instrument Model and Serial Number.

5-7. A Recommended Spare Parts Kit for your basic instrument is available from the factory. This kit contains those items listed in the REC QTY column of the Parts List in the quantities recommended.

5-8. Parts price information is available from the John Fluke Mfg. Co., Inc. or its representatives. Prices are also available in a Fluke Replacements Parts Catalog which is available on request.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. Final Assembly, Model 2020A

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	FINAL ASSEMBLY, MODEL 2020A FIGURE 5-1 (2020A-T&B/4201)						
A1	Ⓟ PRINTER PCB ASSEMBLY	490144	89536	490144	1		
A2	PRINTER MECHANISM ASSEMBLY	490060	89536	490060	1		
F1	FUSE	ORDER	FOR	APPROPRIATE VOLTAGE	1		5
	FUSE, SLO-BLO, 1/2 AMP (90/132V)	109322	71400	MDL1-2			
	FUSE, SLO-BLO, 1/4 AMP (180/250V)	166306	71400	MDL1-4			
F2	FUSE, SLO-BLO, 5 AMP	109215	71400	MDA5A	1		5
H1	NUT, HEX, #6	110551	73734	8006NP	1		
H2	NUT, HEX, S/STEEL, #6	110569	73734	70206	1		
H3	SCREW, FHP, COUNTERSUNK, 6-32 X 5/8	114876	89536	114876	4		
H4	SCREW, THD FORMING	501114	89536	501114	2		
H5	LOCKWASHER, SPLIT	110692	73734	1358	1		
MP1	BAIL	467555	89536	467555	1		
MP2	COVER ASSEMBLY "D" SIZE	516682	89536	516682	1		
MP3	DECAL, BASE SIDES	473652	89536	473652	2		
MP4	DECAL, BOTTOM	483354	89536	483354	1		
MP5	DECAL, NAMEPLATE	504464	89536	504464	1		
MP6	FOOT, NONSKID	467571	89536	467571	4		
MP7	LATCH	467548	89536	467548	2		
MP8	LUG, GROUNDING	132399	78189	2104-06-00	1		
MP9	PAPER HOLDER	490318	89536	490318	1		
MP10	PRINTER FRONT	490276	89536	490276	1		
MP11	PRINTER STOP	521138	89536	521138	1		
MP12	PTI BASE MODIFIED	515734	89536	515734	1		
MP13	REAR PANEL	490201	89536	490201	1		
MP14	PANEL, FRONT	490250	89536	490250	1		
MP15	SPACER, HEX	103895	89536	103895	1		
MP16	THERMAL PAPER	514257	89536	514257	AR		
W1	CABLE ASSEMBLY	475228	89536	475228	1		
W2	LINE CORD (NOT SHOWN)	343723	89536	343723	1		
XF1	FUSEHOLDER BODY	375188	89536	375188	2		
	FUSEHOLDER CAP	460238	89536	460238	2		
XF2	FUSEHOLDER BODY	375188	89536	375188	REF		
	FUSEHOLDER CAP	460238	89536	460238	REF		
	INSTRUCTION MANUAL (2020A)	504035	89536	504035	1		
	RECOMMENDED SPARE PARTS KIT	526095	89536	526095			

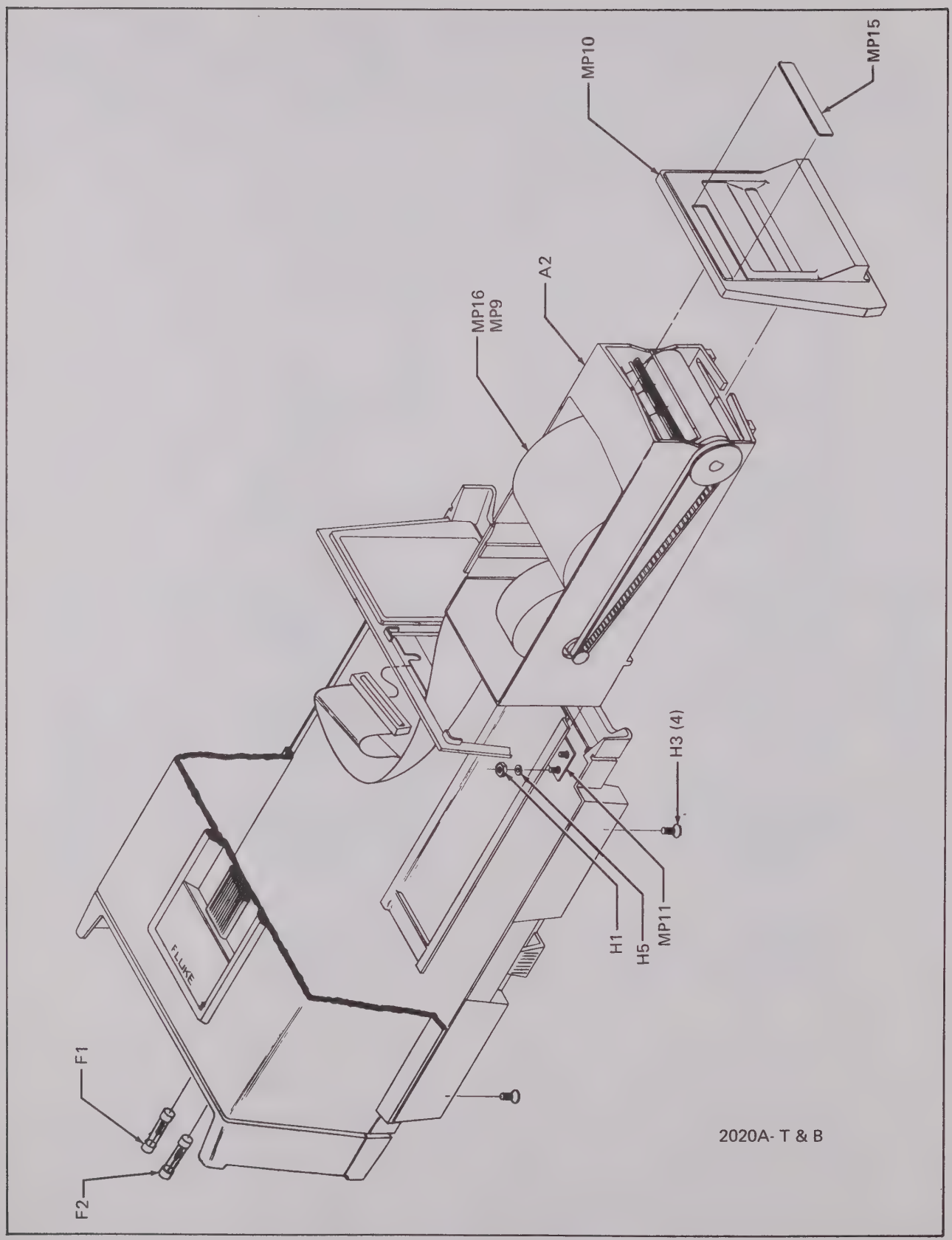


Figure 5-1. Final Assembly, Model 2020A

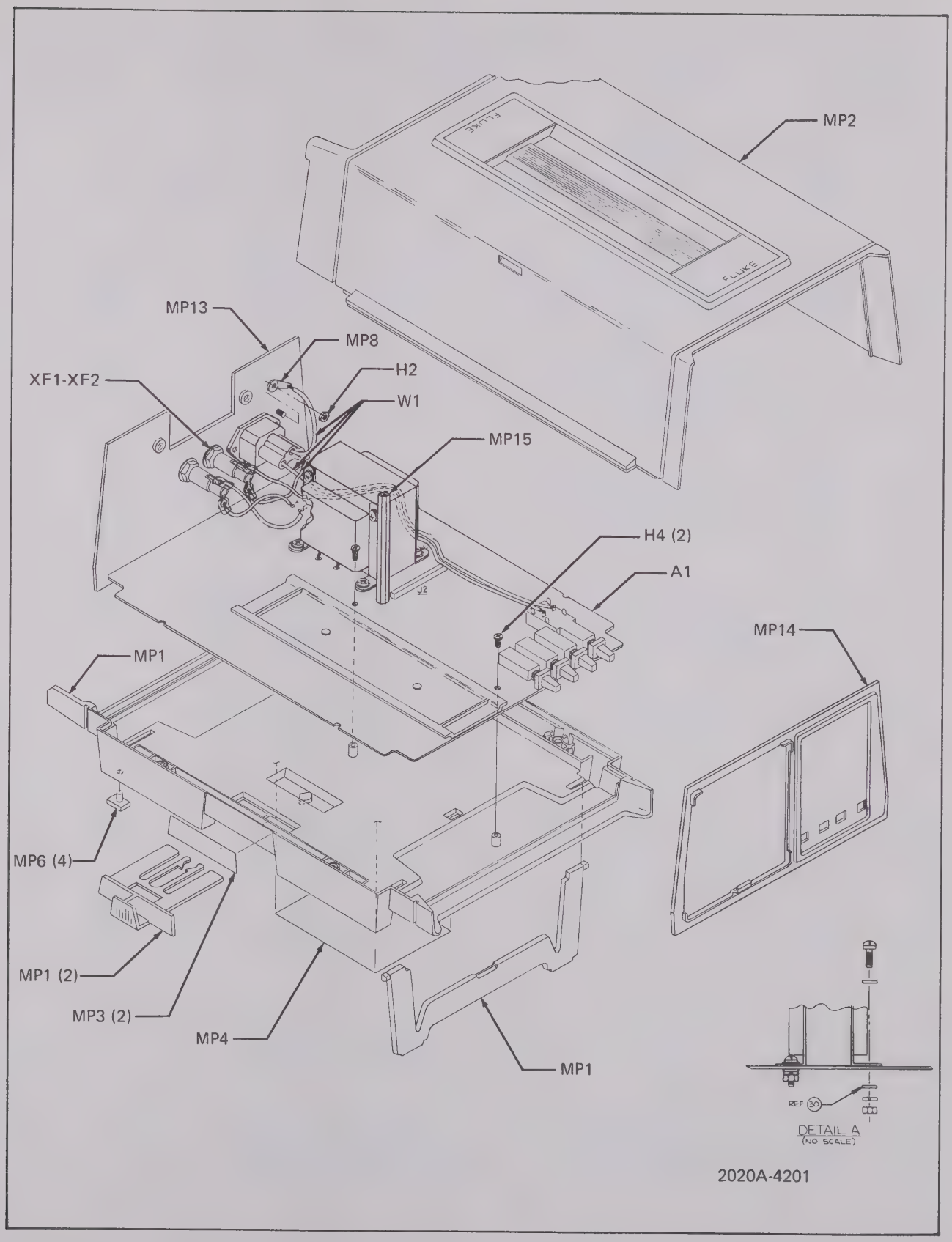


Figure 5-1. Final Assembly, Model 2020A (cont)

Table 5-2. A1 Printer Main PCB Assembly

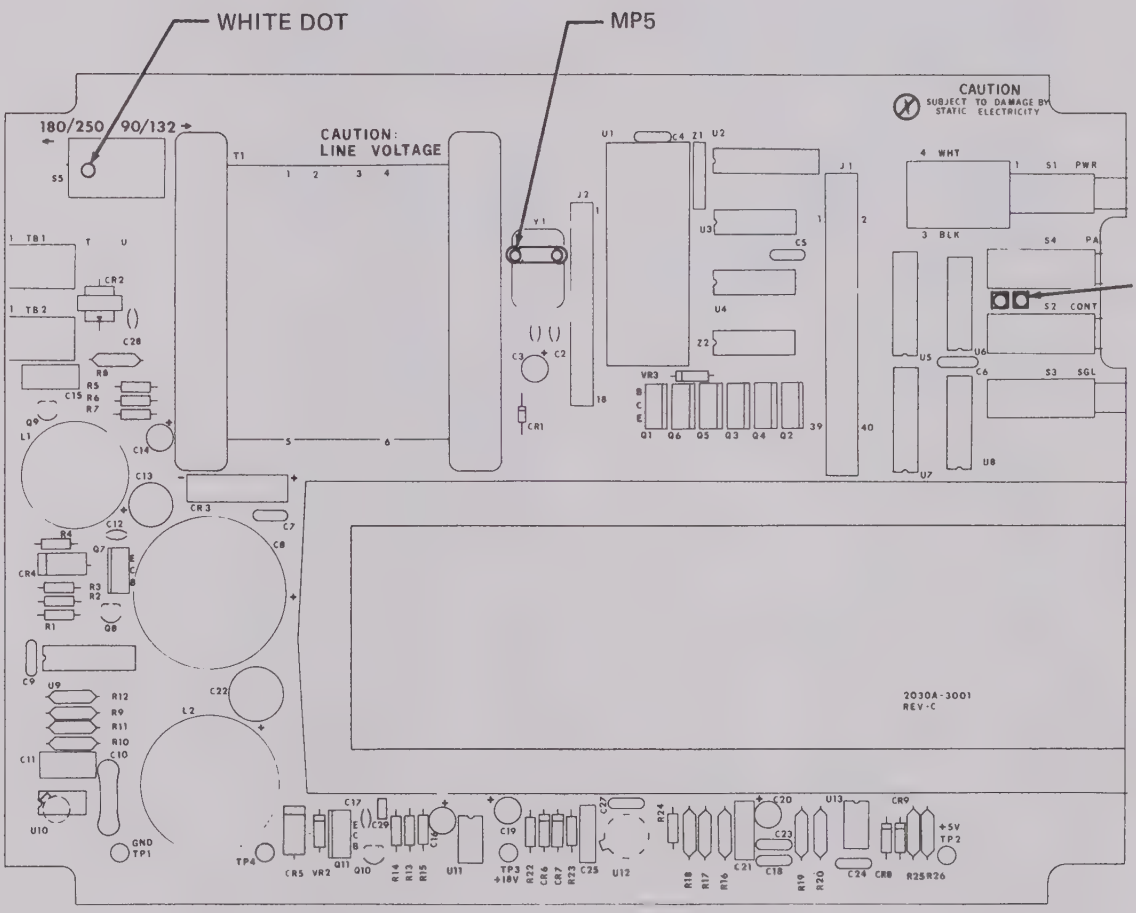
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A1Ⓐ	PRINTER, MAIN PCB ASSEMBLY FIGURE 5-2 (2030A-4001T)	490144	89536	490144	REF		
C1	CAP, CER, 20 PF +/-10%, 500V	106369	72982	831-000-T2H0-200K	2		
C2	CAP, CER, 20 PF +/-10%, 500V	106369	72982	831-000-T2H0-200K	REF		
C3	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	4		
C4	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	9		
C5	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C7	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C8	CAP, ELECT, 4500 UF -10/+75%, 25V	493684	06001	86F537	1		
C9	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C10	CAP, MICA, 3300 PF +/-2%, 500V	192518	72136	DM19F332G	1		
C11	CAP, MYLAR, 0.033 UF +/-10%, 50V	271841	80031	75F1R5A333	1		
C12	CAP, CER, 5000 PF +/-20%, 100V	175232	56289	C023B101E502M	1		
C13	CAP, ELECT, 220 UF -10/+100%, 6.3V	494567	56289	672D227H6R3CG2C	1		
C14	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	1		
C15	CAP, POLYFILM, 0.47 UF +/-10%, 250V	162008	73445	C280MAE/A47K	1		
C16	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C17	CAP, CER, 5000 PF +/-20%, 100V	175232	56289	C023B101E502M	REF		
C18	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C19	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C20	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C21	CAP, POLYESTER, 0.082 UF +/-10%, 250V	342519	89536	342519	1		
C22	CAP, ELECT, 470 UF -10/+100%, 25V	494575	56289	672D477H025DS2C	1		
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C24	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C25	CAP, POLYESTER, 0.010 UF +/-10%, 400V	402818	73445	C280MAH/A10K	1		
C27	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C28	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253M	1		
C29	CAP, CER, .001 UF +/-20%, 500V	402966	32897	8121-A100-W5R-102M	1		
CR1	DIODE, GE	149187	22767	1N270	5	1	
CR2	RECTIFIER, SI	325746	04713	MR751	1	1	
CR3	RECTIFIER BRIDGE	428839	04713	MPA970-1	1	1	
CR4	RECTIFIER, SI, FAST RECOVERY	483701	14099	5FF10	2	1	
CR5	RECTIFIER, SI, FAST RECOVERY	483701	14099	5FF10	REF		
CR6	DIODE, GE	149187	22767	1N270	REF		
CR7	DIODE, GE	149187	22767	1N270	REF		
CR8	DIODE, GE	149187	22767	1N270	REF		
CR9	DIODE, GE	149187	22767	1N270	REF		
J1	CONNECTOR, PLUG	494823	22526	65692-025	1		
J2	SOCKET, CONNECTOR, 18-POS	435024	00779	583773-8	1		
L1	CHOKE	490870	89536	490870	1		
L2	CHOKE	490888	89536	490888	1		
MP1	SPACER, PCB STANOFF	285353	71590	J64284	3		
MP2	SOCKET, COMP.LEAD, PC MOUNT	376418	22526	75060-007	2		
MP3	BUTTON, SW, GRAY (NOT SHOWN)	425900	89536	425900	3		
MP4	BUTTON, SW, GREEN (NOT SHOWN)	445197	89536	445197	1		
MP5	HOLDER, RUBBER COMPONENT	422857	98159	2829-75-1	1		
Q1	XSTR, PWR, PNP	483693	09214	D45E2	6	2	

Table 5-2. A1 Printer Main PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
Q2	XSTR, PWR, PNP	483693	09214	D45E2	REF		
Q3	XSTR, PWR, PNP	483693	09214	D45E2	REF		
Q4	XSTR, PWR, PNP	483693	09214	D45E2	REF		
Q5	XSTR, PWR, PNP	483693	09214	D45E2	REF		
Q6	XSTR, PWR, PNP	483693	09214	D45E2	REF		
Q7	XSTR, SI, PWR NPN	325761	09214	D44C5	1	1	
Q8	XSTR, SI, PNP	195974	04713	2N3906	2	1	
Q9	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q10	XSTR, SI, NPN	330803	04713	MPS6560	1	1	
Q11	XSTR, SI, PWR, NPN	495010	09214	D44H11	1	1	
R1	RES, DEP. CAR, 160 +/-5%, 1/4W	441410	80031	CR251-4-5P160E	1		
R2	RES, DEP. CAR, 910 +/-5%, 1/4W	442335	80031	CR251-4-5P910E	1		
R3	RES, DEP. CAR, 68 +/-5%, 1/4W	414532	80031	CR251-4-5P68E	1		
R4	RES, DEP. CAR, 51 +/-5%, 1/4W	414540	80031	CR251-4-5P51E	2		
R5	RES, DEP. CAR, 1.5 +/-5%, 1/4W	442020	80031	CR251-4-5P1E5	3		
R6	RES, DEP. CAR, 1.5 +/-5%, 1/4W	442020	80031	CR251-4-5P1E5	REF		
R7	RES, DEP. CAR, 1.5 +/-5%, 1/4W	442020	80031	CR251-4-5P1E5	REF		
R8	RES, MTL. FILM, 3.01K +/-1%, 1/8W	312645	91637	CMF553011F	2		
R9	RES, MTL. FILM, 7.15K +/-1%, 1/8W	260356	91637	CMF557151F	1		
R10	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R11	RES, MTL. FILM, 4.02K +/-1%, 1/8W	235325	91637	CMF554021F	1		
R12	RES, MTL. FILM, 3.01K +/-1%, 1/8W	312645	91637	CMF553011F	REF		
R13	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R14	RES, DEP. CAR, 51 +/-5%, 1/4W	414540	80031	CR251-4-5P51E	REF		
R15	RES, DEP. CAR, 27 +/-5%, 1/4W	348763	80031	CR251-4-5P27E	1		
R16	RES, MTL. FILM, 3.24K +/-1%, 1/8W	223578	91637	CMF553241F	1		
R17	RES, MTL. FILM, 1.4K +/-1%, 1/8W	344333	91637	CMF551401F	1		
R18	RES, MTL. FILM, 715 +/-1% , 1/8W	313080	91637	CMF557150F	1		
R19	RES, MTL. FILM, 1.1K +/-1%, 1/8W	241497	91637	CMF551101F	2		
R20	RES, MTL. FILM, 2.67K +/-1%, 1/8W	289587	91637	CMF552671F	1		
R22	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	1		
R23	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R24	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	1		
R25	RES, MTL. FILM, 1.1K +/-1%, 1/8W	241497	91637	CMF551101F	REF		
R26	RES, MTL. FILM, 665 +/-1%, 1/8W	320028	91637	CMF556650F	1		
S1	SWITCH ASSEMBLY	473355	89536	473355	1		
S2	SWITCH ASSEMBLY, PUSHBUTTON	483453	89536	483453	1		
S3	SWITCH ASSEMBLY, PUSHBUTTON	483453	89536	483453	REF		
S4	SWITCH ASSEMBLY, PUSHBUTTON	483453	89536	483453	REF		
S5	SWITCH, SLIDE	234278	82389	XW1649	1		
TB1	TERMINAL BLOCK	479006	89536	479006	2		
TB2	TERMINAL BLOCK	479006	89536	479006	REF		
U2	IC, HI-VOL, HI-CURRENT, XSTR ARRAY	483685	56289	ULN-2803A	3	1	
U3⊘	IC, C-MOS, HEX, INVERTER	404681	04713	MC1406BCP	1	1	
U4	IC, TTL, HEX, BUFFER/DRIVER	328021	01295	SN7417N	1	1	
U5	IC, HI-VOL, HI-CURRENT, XSTR ARRAY	483685	56289	ULN-2803A	REF		
U6⊘	IC, C-MOS, DUAL, 4-BIT STATIC SHFT REG	340125	04713	MC14015BCP	2	1	
U7	IC, HI-VOL, HI-CURRENT, XSTR ARRAY	483685	56289	ULN-2803A	REF		
U8⊘	IC, C-MOS, DUAL, 4-BIT STATIC SHFT REG	340125	04713	MC14015BCP	REF		
U9	IC, LINEAR, REGULATING PULSE WITH MODLTR	454678	01295	SG3524N	1	1	

Table 5-2. A1 Printer Main PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U10	IC, LINEAR, 2.5V BAND GAP REF	472845	04713	MC14030	1	1	
U11	IC, LINEAR, VOLTAGE COMPARATOR	352195	01895	SN72311P	1	1	
U12	IC, LINEAR, OP AMP	453357	02735	CA3140T	1	1	
U13	IC, LINEAR, LO-PWR, DUAL VOL COMPARATOR	478354	01295	LM393N	1	1	
VR2	DIODE, 6.8V	260695	07910	1N754A	2		
VR3	DIODE, 6.8V	260695	07910	1N754A	REF		
XU1	SOCKET, IC, 40-PIN (NOT SHOWN)	418983	09922	DILB40P-108	1		
Y1	CRYSTAL, 6 MHZ	461665	89536	461665	1		
Z1	RES, NETWORK, 4.7K	494690	89536	494690	1	1	
Z2	RES, NETWORK, 1K	407445	89536	407445	1	1	

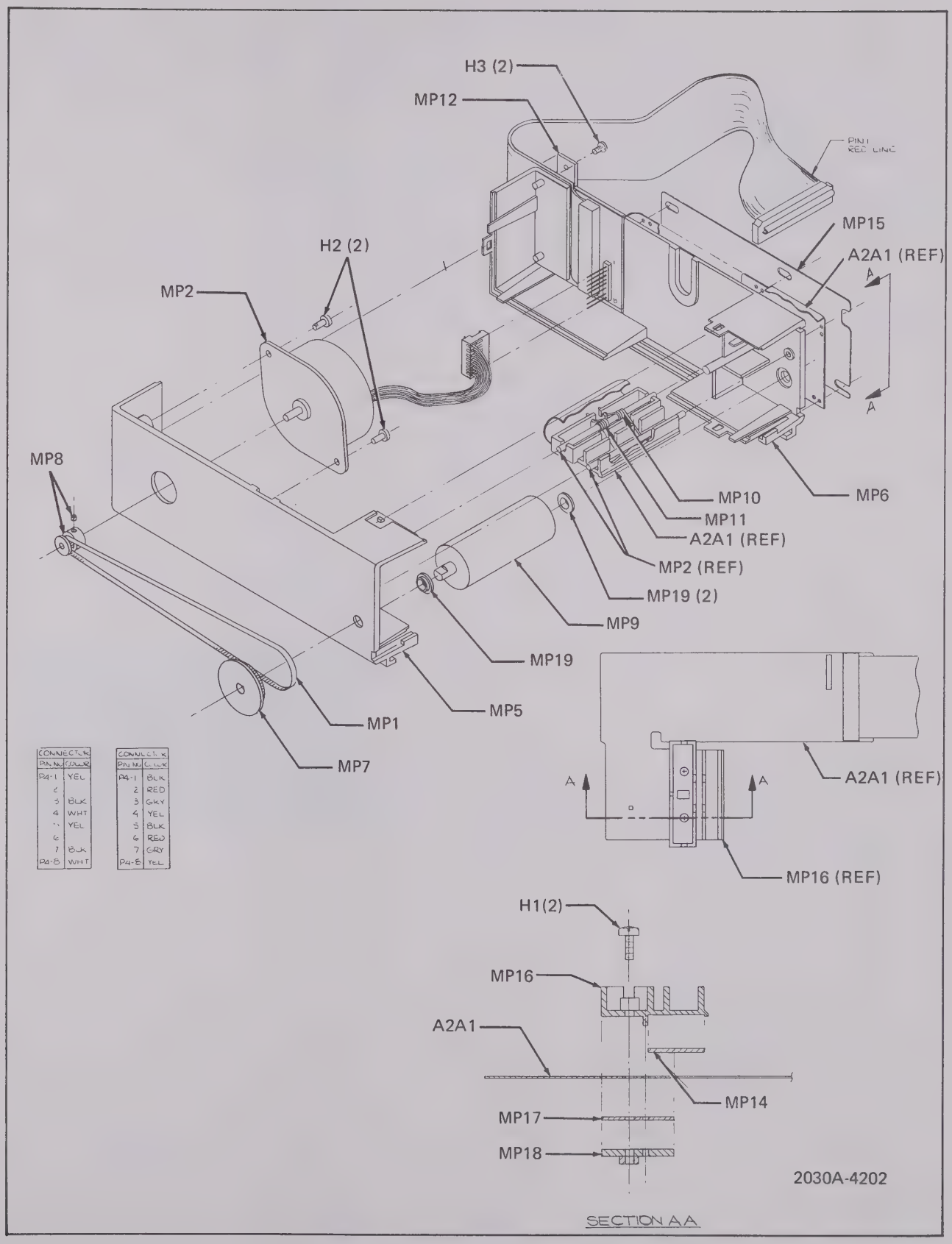


2030A-1601

Figure 5-2. Printer, Main PCB Assembly

Table 5-3. A2 Printer Mechanism Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A2	PRINTER MECHANISM ASSEMBLY FIGURE 5-3 (2030A-4202)	490060	89536	490060	REF		
A2A1	INTERCONNECT ASSEMBLY	521047	89536	521047	1		
H1	SCREW, PHP, 4-40 X 1/4, SEMS	185918	89536	185918	2		
H2	SCREW, PHP, TH/FORM 8-18 X 5/16	513648	78189	HI-LO 8-18 X 5/16	2		
H3	SCREW, PHP, TH/FROM 4-9 X 1/4	519116	78189	HI-LO 4-9 X 1/4	2		
MP1	BELT, TOOTHED TIMING	500926	89536	500926	1		
MP2	MOTOR, STEPPING	500082	82227	A82770	1		
MP3	CONNECTOR, TERMINAL CABLE	494088	00779	530553-2	8		
MP4	PIVOT ROD	503318	89536	503318	2		
MP5	PRINTER CHASSIS, LEFT	490292	89536	490292	1		
MP6	PRINTER CHASSIS, RIGHT	490284	89536	490284	1		
MP7	PULLEY	490334	89536	490334	1		
MP8	PULLEY, TOOTHED TIMING	500934	89536	500934	1		
MP9	RUBBER ROLLER	495291	89536	495291	1		
MP10	SPRING, LEFT HAND	504811	89536	504811	1		
MP11	SPRING, RIGHT HAND	504803	89536	504803	1		
MP12	STRAIN RELIEF	521146	89536	521146	1		
MP13	PRINTHEAD ASSEMBLY	490078	89536	490078	1		
MP14	PRINTHEAD THERMAL	483677	89536	483677	1		
MP15	DECAL, INSTRUCTION CARD	508374	89536	508374	1		
MP16	HEATSINK	504571	89536	504571	1		
MP17	PAD	504654	89536	504654	1		
MP18	PRINTHEAD RETAINER	490300	89536	490300	1		
MP19	BEARING, SINTERED BRONZE * STOCK DRIVE PRODUCTS	513499	*	74B-F004	2		
P4	CONNECTOR, 8-POSITION CABLE	494120	00779	530554-7	1		



CONNECTOR	
PIN NO.	COLOR
P4-1	YEL
2	
3	BLK
4	WHT
5	YEL
6	
7	BLK
P4-8	WHT

CONNECTOR	
PIN NO.	COLOR
P4-1	BLK
2	RED
3	GRY
4	YEL
5	BLK
6	RED
7	GRY
P4-8	YEL

Figure 5-3. A2 Printer Mechanism Assembly

Table 5-4. A2A1 Interconnect Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A2A1	INTERCONNECT ASSEMBLY FIGURE 5-4 (2030A-4004)	521047	89536	521047	REF		
J4	POST CONTACT, 8-POSITION	520502	89536	520502	1		
J5	CABLE ASSEMBLY, PRINTER	483834	89536	483834	1		
MP1	PCB ASSEMBLY, INTERCONNECT	490193	89536	490193	1		
R1	RES THERMISTOR, 10K +/-10%, 3 MW	104596	15801	JA41J1	1		

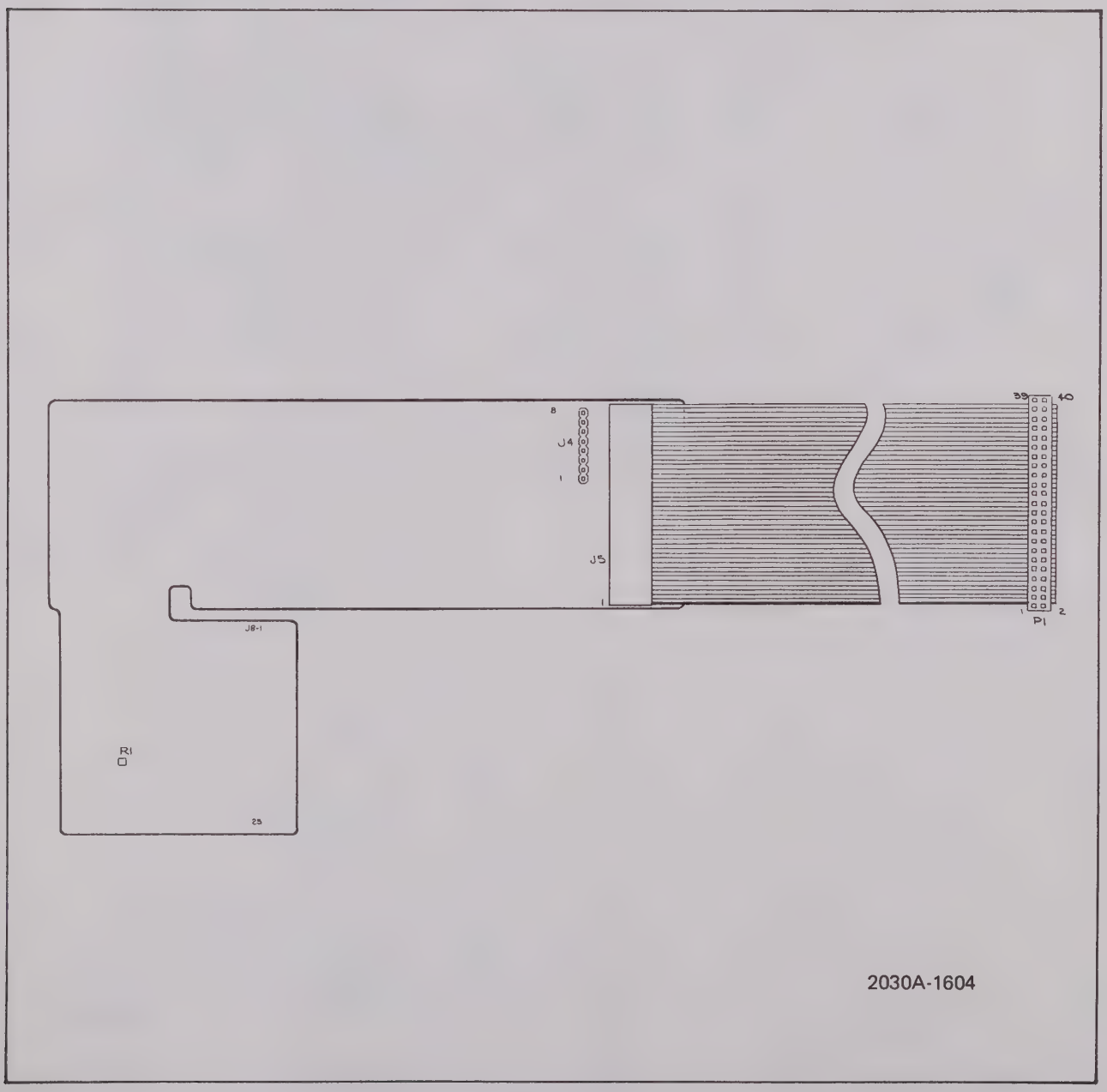


Figure 5-4. A2A1 Interconnect Assembly

Section 6
Option & Accessory Information

TABLE OF CONTENTS

OPTION/ MODEL NO.	DESCRIPTION	PAGE
	OPTIONS	
Y7203	Interconnect Cable, 2 ft.	600-1
Y7204	Interconnect Cable, 5 ft.	600-1
Y2028	Converter Module	600-1
Y2034	Interconnect Accessory	600-2
	ACCESSORIES	
-001	Parallel ASCII Interface	601-1
-002	RS-232-C Interface	602-1
-003	IEEE-488 Interface	603-1
-004	PTI Interface	604-1
-005	Parallel BCD Interface	605-1
-006	Interval Timer	606-1

6-1. INTRODUCTION

6-2. This section of the manual contains information concerning the options and accessories available for use with the Model 2020A Printer. It consists of an introductory section, an accessory section, and series of option subsections. All options and accessories are listed by model number or option number in the Table of Contents. Corresponding subsection page numbers are listed, as is additional documentation location information.

6-3. ACCESSORIES

6-4. The less complex accessories are fully documented in the Accessories subsection; complex accessories (Y2028, Y2034) are briefly described in the Accessories subsection and fully documented in stand-alone manuals which are provided with the accessory when purchased. Each option is documented in individual subsections of this manual section. Each subsection contains all information necessary to install, operate and maintain the option, including a list of replaceable parts and a schematic.

6-5. OPTIONS

6-6. Unique page and paragraph numbering, which corresponds to the option number, facilitates subsection location. For example, a page numbered 604-2, is the second page of information concerning Option -004. A paragraph numbered 604-2 is the second paragraph concerning Option -004.

Accessories

600-1. INTRODUCTION

600-2. Four accessories are available for use with the Model 2020A Printer: two cable assemblies (Y7203, Y7204), an interface, BCD to PTI Converter (Y2028), and an Interconnect accessory (Y2034). The BCD to ASCII Interface and the Interconnect accessory are documented in stand-alone manuals supplied with the accessory when purchased.

600-3. CABLE ASSEMBLIES

600-4. Both cable assembly accessories are direct pin-to-pin cables for use with 2020A Printers operating with either the Parallel ASCII Interface (Option -001) or the PTI Interface (Option -004). Both cables have a 36-pin Amp "Champ" male connector at one end, and a 36-pin Amp "Champ" female connector at the other end. The Y7203 cable is 2 feet long; the Y7204 cable is 5 feet long.

600-5. INTERFACE (BCD TO PTI)

600-6. Accessory Y2028 is an interface that converts BCD input data to ASCII format output data compatible with the Fluke PTI system instruments. It may be used to interface BCD format instruments to the Model 2020A Printer with either the Parallel ASCII Interface or the PTI Interface installed. The Y2028 is packaged in an A size PTI case, which may be stacked and latched to additional PTI case instruments to form a portable test system. Case dimensions are: 5.72 cm high, 20.45 cm wide, and 32.64 cm deep. Input data is received through 100 card-edge connections on the rear panel. The input is plug compatible with the 2210 Series interface cables. Additional signal and connector information is available in the Y2028 Interface (BCD to PTI) Instruction Manual.

600-7. A cable-mounted, 36-pin female Amp "Champ" connector provides plug compatible output connection to the 2020A using Option -001, the Parallel ASCII Interface, or Option -004, the PTI Interface. The Y2028 output is also plug compatible with the Interconnect Accessory, Y2034. Refer to the Model Y2028 Interface (BCD ot PTI) Instruction Manual for additional information.

600-8. The Y2028 Interface meets all temperature, humidity, and vibration specifications listed for the 2020A Printer. Additional specifications are listed in Table 600-1.

Table 600-1. Y2028 Specifications

INPUT CONNECTIONS	100 Card-Edge
OUTPUT CONNECTOR	36-pin, cable mounted
INPUT DATA FORMAT	Parallel BCD
OUTPUT DATA FORMAT	ASCII
PLUG COMPATIBLE	2020A, 2021A w/Option -001, -004, 2030A, Y2034

600-9. INTERCONNECT ACCESSORY

600-10. The Model Y2034 Interconnect Accessory provides multiple input capability for Model 2020A Printers with the PTI Interface (Option -004) installed. It also has a storage drawer for customer use.

600-11. All input and output data must be in the PTI format. Five PTI format, digital test instruments may be connected to the five male connectors using Cable Accessories, Y7203 or Y7204. One female output connector may be connected to the printer using either cable accessory. Pins 1 through 18 of all input connectors and pins 1 through 18 of the output connector are bussed together. Pins 19 through 36 of all connectors are open.

600-12. The Model Y2034 Interconnect Accessory meets all temperature. humidity, and vibration specifications listed for the Model 2020A Printer. Additional specifications are listed in Table 600-2.

Table 600-2. Y2034 Specifications

INPUT CONNECTORS	5- 36- pin male	
OUTPUT CONNECTOR	1 - 36- pin female	
INPUT DATA FORMAT	PTI	Passive device, no signal changes
OUTPUT DATA FORMAT	PTI	
PLUG COMPATIBLE	All Fluke PTI format instruments, Y2028.	

Option -001
Parallel ASCII Interface

601-1. INTRODUCTION

601-2. The Parallel ASCII Interface, Option -001, for the 2020A Printer, provides buffering between the Data Bus and the 2020A microcomputer. Input data must be in the ASCII format, seven data bits. Through the Parallel ASCII Interface, the 2020A Printer will respond to all of the 64 upper-case ASCII characters plus the special characters listed in Table 601-1. The parity bit is not used. The printer may also be used in the plot mode with the Parallel ASCII Interface installed. An ASCII code, Control P, initiates plot mode operation, in which all data is interpreted as binary dot position codes. A binary 0 is the furthest left dot position; a binary 99 is the furthest right position. A binary input equivalent to decimal 254 is a paper advance command, and a binary equivalent of decimal 255 returns the printer to the standard ASCII operating mode. All data is transferred using the handshake sequence.

601-3. The Parallel ASCII Interface is factory or field installable, and it is compatible with the Interval Timer, Option -006. Address lines are set at hex 1 (binary 0001) for compatibility with other Fluke instruments, primarily the 2180A and 2190A Digital Thermometers. All data is received through a 36-pin Amp "Blue Ribbon Type" series connector. Input connector pin assignments are listed in Table 601-2.

601-4. SPECIFICATIONS

601-5. The Parallel ASCII Interface meets all temperature, humidity, vibration, and power specifications listed for the 2020A Printer. Additional specifications applicable to the Parallel ASCII Interface are listed in Table 601-3.

Table 601-1. Special Printer Characters

ASCII CODE CHARACTER	PRINTER CHARACTER
Control J (Line Feed)	Terminate Input String
Control L (Form Feed)	Space One Line
Control P	Initiate Plot Mode
Decimal 254	Advance Paper
Decimal 255	Terminate Plot Mode
Lower Case d	Degree Symbol (°)
Lower Case f	Lower Case f
Lower Case k	Lower Case k
Lower Case m	Lower Case m
Lower Case n	Lower Case n
Lower Case p	Lower Case p
Lower Case r	Omega Symbol (Ω)
Lower Case s	Lower Case s
Lower Case u	Micro Symbol (μ)
Lower Case z	Lower Case z

601-6. INSTALLATION

601-7. To install or exchange input interface options, use the following procedure:

1. Disconnect all 2020A power and signal connections.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear of the unit by pulling straight up.

NOTE

Steps a and b are necessary only if the 2020A Printer is equipped with Interval Timer, Option -006.

a. Remove the retaining screws and pull the rear edge of the Interval PCB up to disconnect it from the interface pcb.

b. Pull the Interval PCB toward the rear of the 2020A Printer to disconnect it from the Keyboard PCB.

4. Remove the single screw at the front of the Interface PCB and the two screws securing the connector to the 2020A Printer rear panel.

5. Disconnect the ribbon cable between the interface pcb and the 2020A Printer PCB, then remove the interface pcb.

6. To reinstall the interface pcb, first reconnect the ribbon cable between the interface pcb and the 2020A Printer PCB.

7. Position the interface pcb and install the three retaining screws. (One at the front and two securing the input connector.)

NOTE

Reinstall the Interval Print PCB if necessary.

8. Replace the 2020A Printer cover.

9. Replace the four cover retaining screws.

601-8. OPERATING INSTRUCTIONS

601-9. Model 2020A Printer operating instructions are valid for printers with the Parallel ASCII Interface installed. If the Interval Timer, Option -006 is also installed, refer to the Interval Timer operating instructions.

601-10. THEORY OF OPERATION

601-11. Option -001, the Parallel ASCII Interface, provides buffering between the input ASCII Bus and the 2020A Printer microcomputer. It buffers both the ASCII data and the handshake signals. Refer to Figure 601-1, Parallel ASCII Interface Block Diagram.

Table 601-2. Input Connector Pin Assignments

PIN NO.	MNEMONIC	DESCRIPTION
1	$\overline{\text{ADRVL}}$	Address Valid
2	$\overline{\text{DATVL}}$	Data Valid
3	A0	Instrument Address, LSB
4	A1	Instrument Address, 2SB
5	A2	Instrument Address, 3SB
6	A3	Instrument Address, MSB
7	$\overline{\text{DTACK}}$	Data Acknowledge
8	$\overline{\text{SCNIP}}$	Scan In Progress
9	D0	LSB (Input Data Lines)
10	D1	2SB
11	D2	3SB
12	D3	4SB
13	D4	5SB
14	D5	6SB
15	D6	7SB
16	D7	MSB
17	GND	Common Return
18	+5	Supplied by printer
19-36	---	Not used by printer

Table 601-3. Parallel ASCII Interface Specifications

Input Connector	Qty. 1; 36-pin amp
Data Inputs	7 lines; Parallel ASCII
Address	4 lines; input instrument must be set to Address 1.
Handshake Signals	Address Valid ($\overline{\text{ADRVL}}$), Data Valid ($\overline{\text{DATVL}}$), Data Acknowledge ($\overline{\text{DTACK}}$)
Logic Sense	
Address & Data	Positive-true ($\geqslant$3.5V)
Handshake	Negative-true ($\leqslant$1.5V)
Plug Compatible	2180A and 2190A
Character Set	64 Upper Case ASCII plus special characters listed in Table 601-1.
Buffer Storage	None

601-12. In the handshake data transfer mode, each ASCII character must go through a complete handshake sequence. Refer to Figure 601-2, Handshake Format Timing. When the Address goes true, Data Valid (DATVL) can be set true if Data Acknowledge (DTACK) is false. Once DTACK goes true (low), DATVL can go false (high) immediately. When DTACK returns false (high), then DATVL may go true (low) again to transfer the next character. Data transfer is complete when the 2020A Printer recognizes a 0A hex code (ASCII Line Feed) on the data lines.

601-13. In addition to the data and handshake lines, the Single Print (SINGLE) and Continuous Print (CONT) commands are also buffered by Parallel ASCII Interface circuits. Both print commmands are passed through one buffer, and the presence of either generates a PRINT input to the 2020A microcomputer. Address Valid (ADRVL) and Scan In Progress (SCNIP) are not connected.

601-14. All input data signal high and low states are based on standard "B" series CMOS requirements. All signals must be active true. For the low state, input voltage must not exceed +.7V at +.36 mA. In the instrument supplying data, address line resistive termination should be greater than 100 kΩ, tied to +5V only.

NOTE

Input low logic level must be ≤.7V. Output low logic level must be ≤1.5V due to noise tolerance margin.

601-15. MAINTENANCE

601-16. Refer to Section 4 of this manual for service information, cleaning instructions, and general maintenance instructions.

601-17. Performance Test

601-18. Proper operation of the Parallel ASCII Interface can best be verified under actual operating conditions. Install the Parallel ASCII Interface PCB in a known good 2020A Printer, and connect it to a known good input instrument. Compare the printer output to the input instrument indication.

601-19. Calibration Adjustments

601-20. No periodic or post-repair calibration adjustment is required for the Parallel ASCII Interface.

601-21. Troubleshooting

601-22. Troubleshooting information presented in Table 601-4 is intended as a guide to assist in malfunction isolation. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision is required, perform the next step on the table in sequence.

601-23. LIST OF REPLACEABLE PARTS

601-24. A list of replaceable parts for the Parallel ASCII Interface is given in Table 601-5. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

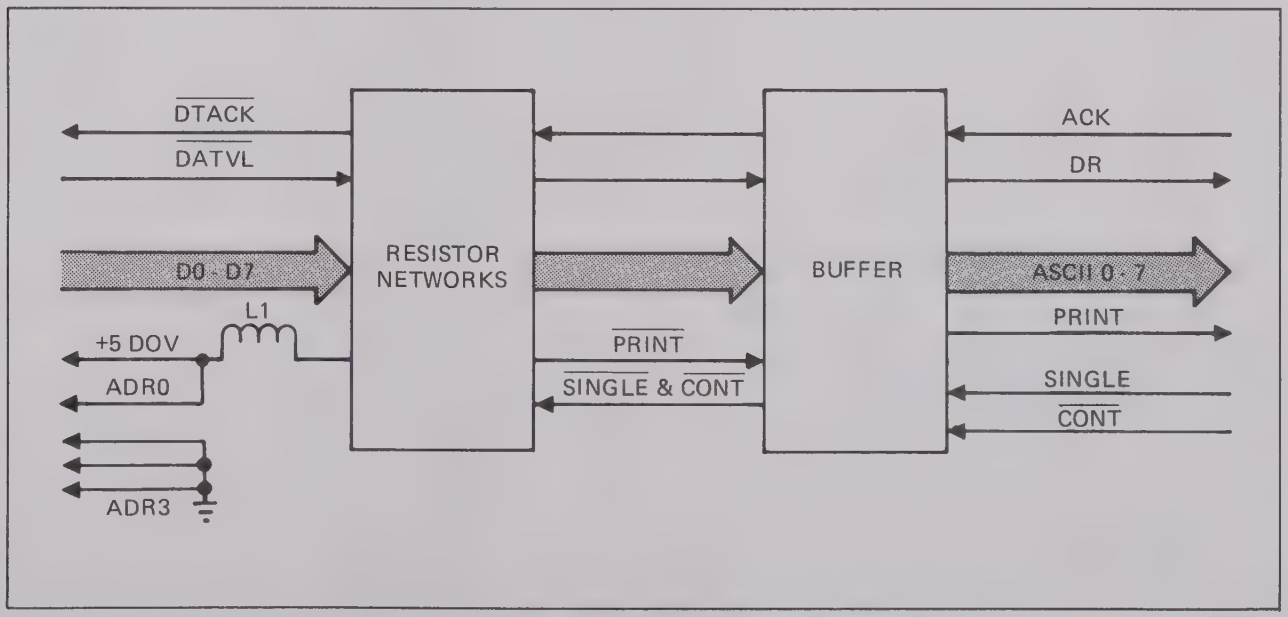
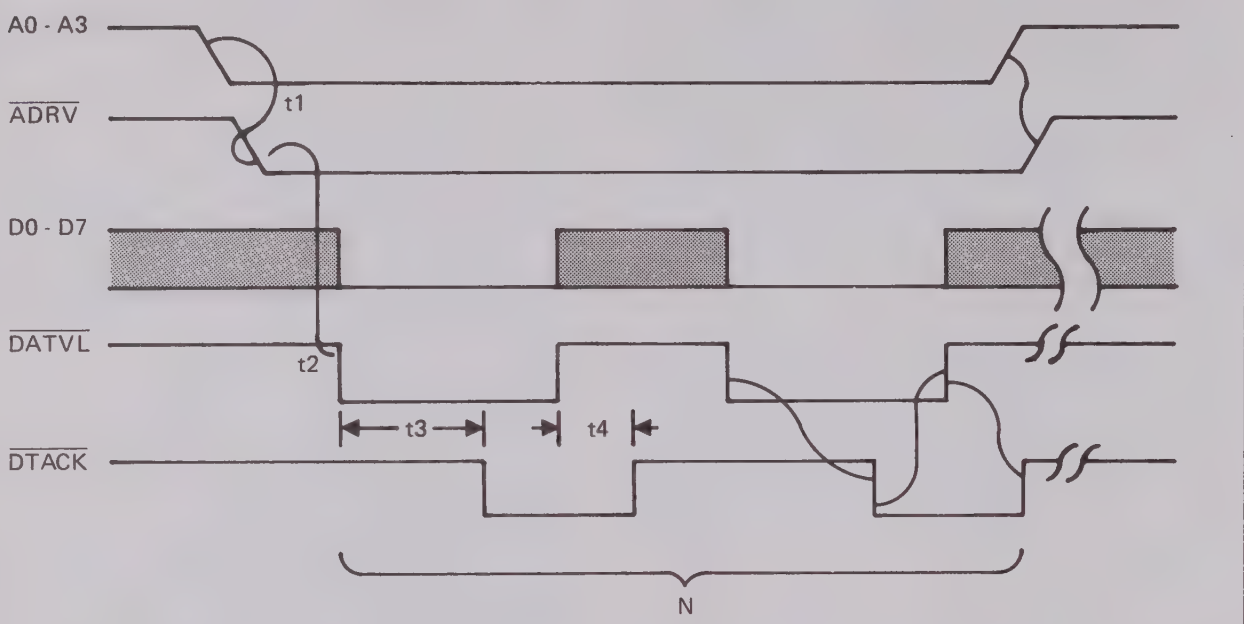


Figure 601-1. Parallel ASCII Interface Block Diagram



t1 = 5 μsec MAX
t2 = 0 μsec MIN
t3 = DATA VALID TO ACKNOWLEDGE ASSERTED (MAX .33 sec,MIN 35 μsec)
t4 = DATA VALID CLEARED TO ACKNOWLEDGE CLEARED (MAX 250 μsec, MIN 40 μsec)
N = NUMBER OF DATA BYTES

Figure 601-2. Handshake Format Timing Diagram

Table 601-4. Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Does all data fail to transfer?	2	3
2	Check Address and Handshake lines.		
3	Does incorrect or incomplete data transfer?	4	5
4	Check individual data lines and buffers.		
5	Troubleshooting is complete.		

Table 601-5. Parallel ASCII Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	PARALLEL ASCII INTERFACE PCB ASSEMBLY FIGURE 601-3 (2020A-4010)	ORDER	BY	OPTION -001			
C1	CAP, TA, 10 UF +/-20%, 10V	176214	56289	196D106X0010KAI	1		
C2	CAP, TA, 10 UF +/-20%, 10V	176214	56289	196D106X0010KAI	REF		
H1	HARDWARE KIT, (TO J6, NOT SHOWN)	484196	00779	552568-1	1		
H2	SCREW, THRD/FORM (UNDER J6, NOT SHOWN)	448456	89536	448456	2		
J3	CONNECTOR, BRD MOUNT	267476	00779	85861-2	8		
J6	CONNECTOR, 36-PIN	493783	00779	552743-1	1		
J7	CONNECTOR SOCKET	435024	00779	583773-8	1		
L1	CHOKE, 6-TURN	320911	89536	320911	1		
MP1	ADAPTER ASSEMBLY (TO J6, NOT SHOWN)	497313	89536	497313	1		
R1	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
U1	⊗IC, C-MOS, TRI-ST HEX, NON-INVRT BUFFERS	407759	04713	MC14503CP	2	1	
U2	⊗IC, C-MOS, TRI-ST HEX, NON-INVRT BUFFERS	407759	04713	MC14503CP	REF		
Z1	RES, NETWORK, 100K	404624	89536	404624	1	1	
Z2	RES, NETWORK, 10K	364000	89536	364000	2	1	
Z3	RES, NETWORK, 10K	364000	89536	364000	REF		

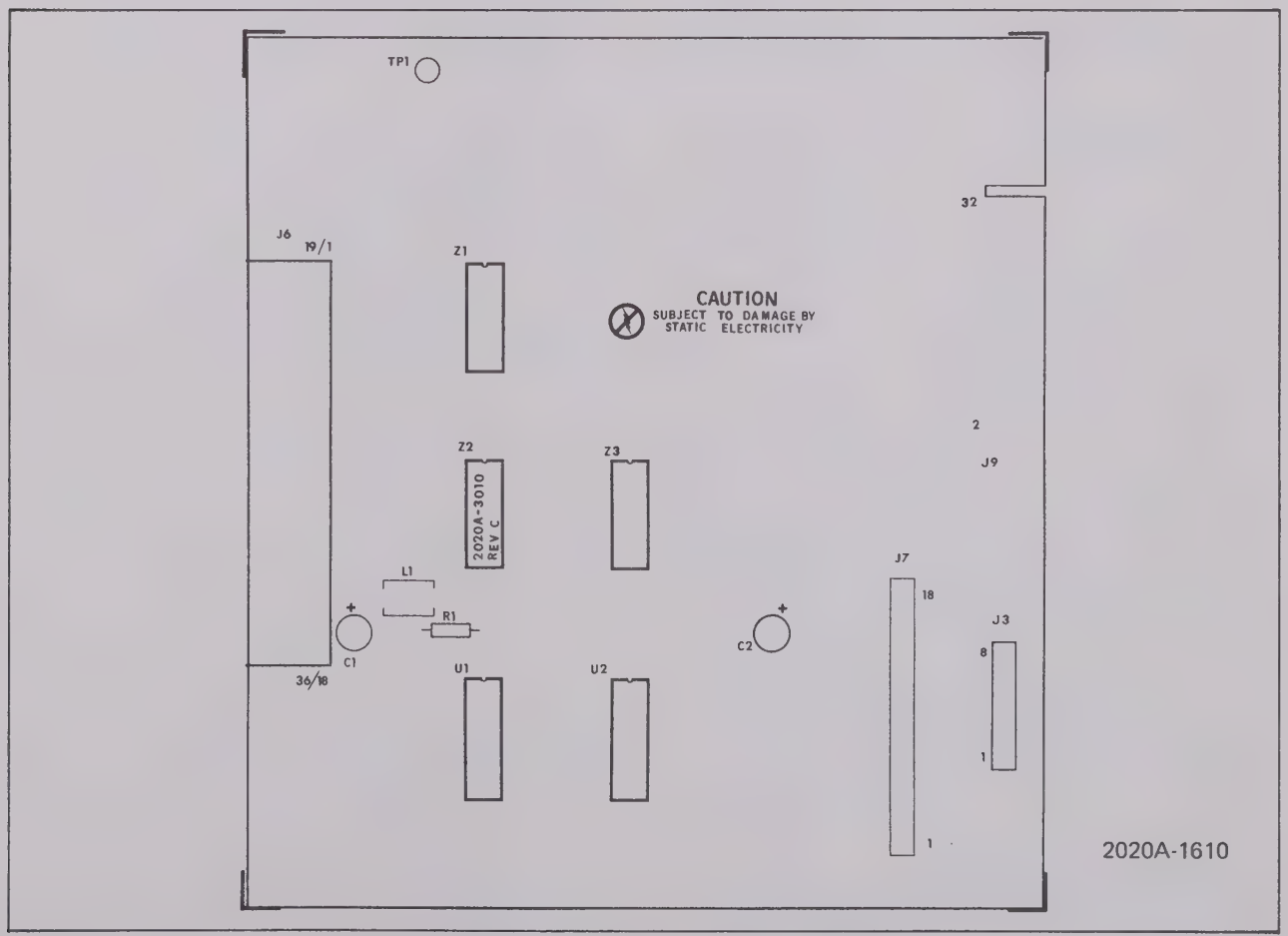


Figure 601-3. Parallel ASCII Interface PCB Assembly

Option -002
RS-232-C Interface

602-1. INTRODUCTION

602-2. Option -002 for the 2020A Printer, the RS-232-C Interface, accepts bit-serial ASCII format information and converts it to bit-parallel ASCII information for input to the 2020A Printer microcomputer. It contains a 32-word buffer which allows input data rates to exceed the printer speed. An active Clear to Send (CTS) signal is provided to prevent buffer overflow, and baud rate is internally switch selectable.

602-3. The RS-232-C Interface is factory or field installable, and it is compatible with the Interval Timer, Option -006. All input data and voltage levels conform to the Electronic Industries Association's (EIA) Standard RS-232-C. Electrical connection is through a 25-pin female connector, wired to appear as a data communication (Modem) device to the input equipment. Connector pin usage is listed in Table 602-1. The printer character set consists of the 64 upper-case ASCII characters.

Table 602-1. Pin Usage

PIN NO.	USE
2	BA - Transmitted Data
5	CTS - Clear To Send
6	DSR - Data Set Ready
7	AB - Signal Ground
8	DCD - Received Line Signal Detector

602-4. SPECIFICATIONS

602-5. The RS-232-C Interface meets all temperature, humidity, vibration, and power specifications listed for the 2020A Printer. Additional specifications applicable to the RS-232-C Interface are listed in Table 602-2.

Table 602-2. RS-232-C Interface Assembly Specifications

Input Connector	Qty. 1; 25- pin
Data Input Lines	1; Serial ASCII (RS-232-C)
Control Signals	DSR, DCD, CTS
Scan Capability	None
Character Set	64 Upper Case ASCII
Baud Rate	Switch selectable; 110, 150, 300, 600, 1200
Buffer Storage	32 characters

602-6. INSTALLATION

602-7. To install or exchange input interface options, use the following procedure:

1. Disconnect all 2020A power and signal connections.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear of the unit by pulling straight up.

NOTE

Steps a and b are necessary only if the 2020A Printer is equipped with Interval Timer, Option -006.

a. Remove the retaining screws and pull the rear edge of the interval pcb up to disconnect it from the interface pcb.

b. Pull the Interval PCB toward the rear of the 2020A Printer to disconnect it from the Keyboard PCB.

4. Remove the single screw at the front of the interface pcb and the two screws securing the connector to the 2020A Printer rear panel.

5. Disconnect the ribbon cable between the interface pcb and the 2020A Printer PCB, then remove the interface pcb.

6. To reinstall the interface pcb, first reconnect the ribbon cable between the interface pcb and the 2020A Printer PCB.

7. Position the interface pcb and install the three retaining screws. (One at the front and two securing the input connector.)

NOTE

Reinstall the Interval Timer PCB if necessary.

8. Replace the 2020A Printer cover.

9. Replace the four cover retaining screws.

602-8. OPERATING INSTRUCTIONS

602-9. Model 2020A Printer operating instructions are valid for printers with the RS-232-C Interface installed. However, the operator should verify that the correct baud rate has been selected through switch S1. Refer to Table 602-3 for switch options and baud rates. If the Interval Timer (Option -006) is also installed, refer to the Interval Timer operating instructions.

Table 602-3. Baud Rate Selection; Switch S1

	110	150	300	600	1200
S1-1	Open	Open	Open	Closed	Open
S1-2	Open	Open	Closed	Open	Open
S1-3	Open	Closed	Open	Open	Open
S1-4	Closed	Open	Open	Open	Open
S1-5	Open	Open	Open	Open	Closed

602-10. THEORY OF OPERATION

602-11. Overall Functional Description

602-12. Circuitry in the RS-232-C Interface Assembly converts bit-serial ASCII information conforming to EIA standard RS-232-C to bit-parallel, byte-serial ASCII information for input to the 2020A Printer microcomputer. The input data comprises one start bit, seven data bits, one polarity bit (not checked), and one or two stop bits. Refer to Figure 602-1. Conversion to parallel ASCII and transfer to the printer involves nine separate circuit functions: a Schmitt trigger input circuit, a universal asynchronous receiver-transmitter (UART), a First In, First Out (FIFO) buffer circuit, a clear to send function, a baud rate generator, a power supply, a clock, a divide-by-11 flip-flop circuit, and a print command circuit. The Schmitt trigger, UART, and FIFO provide a direct data path; all other circuits provide control and data transfer functions.

602-13. Block Diagram Description

602-14. Serial ASCII data enters the Schmitt trigger input circuit on the BA line, through connector J6, pin 2. The Schmitt trigger, through its fast turn on and shut off times, assures a clean, sharp data pulse input to the UART. Positive feedback is provided through a 10 kΩ resistor.

602-15. Data is transferred from the Schmitt trigger input circuit in serial form, through an AND gate, into the universal asynchronous receiver-transmitter (UART). When a complete character has been received in the UART, the Data Ready (DR) UART output goes high (+5V). A high logic level on the UART DR line initiates data transfer to the FIFO buffers. When data has been accepted, the FIFO Data Input Ready (IR) signals go low, and, through AND gating, reset the UART DR flag by providing a UART Data Ready Reset (DRR) input. If the FIFOs are full, the IR signals will remain low, thus, setting the UART DRR low. When the FIFO is full, and the IR signals remain low, the input to Q6 will be high. Transistor Q6 will remain off, allowing –10V dc to be present on line CC, the Clear to Send line. This CC –10V dc informs the input instrument that the interface cannot accept data at that time.

602-16. When data enters the FIFO buffers, it is shifted through them to the first open location. When the last open location is filled, the Output Ready (OR) flag is set high. If the Acknowledge Signal (ACK) from the 2020A microcomputer is also high, the Data Ready (DR) signal to the microcomputer (J7, pin 3) will go low as a result of AND gating the OR and ACK signals. When DR goes low, informing the microcomputer it has Data Ready, the microcomputer will read the data, then assert ACK low to inform the FIFO that data has been read. When ACK goes low, it will remove the DR signal and, through the FIFO Shift Out (SO) input, it will empty the last FIFO location. All remaining FIFO data will then shift one location toward the output. The DR signal goes low

during data shift and will remain low until a new data word is in the last FIFO location. FIFO capacity is 32 data words. A RESET input from the Printer PCB, through a transistor, clears both the UART and all FIFOs.

602-17. Although the data is shifted out of the FIFO buffer to the 2020A Printer microcomputer, the data will not be printed unless the microcomputer receives a PRINT input. Either a Single or Continuous or Interval print input from the 2020A Printer PCB, through OR gating, will turn on a transistor and provide a low logic (0V) PRINT output.

602-18. Baud rate generation involves a clock circuit, a binary ripple counter used as a baud rate generator, and a divide-by-11 divider circuit. The clock circuit is a timer, operating in an astable mode, to produce an output frequency of 38.4 kHz. Duty cycle is 33%. A potentiometer provides output frequency adjustment; clock output is available at TP2 for test and adjustment purposes. See Figure 602-2 for the clock output waveform.

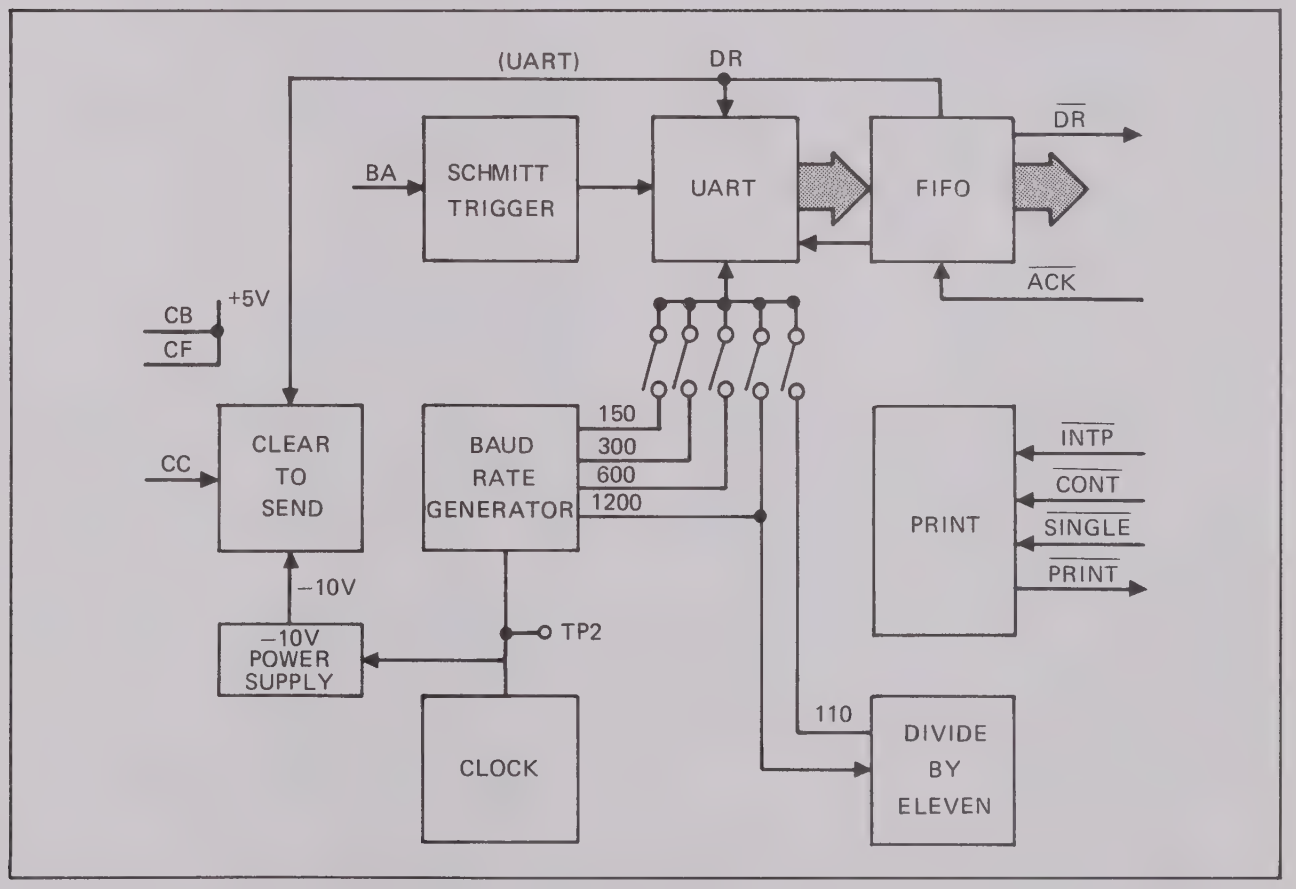


Figure 602-1. RS-232-C Interface Block Diagram

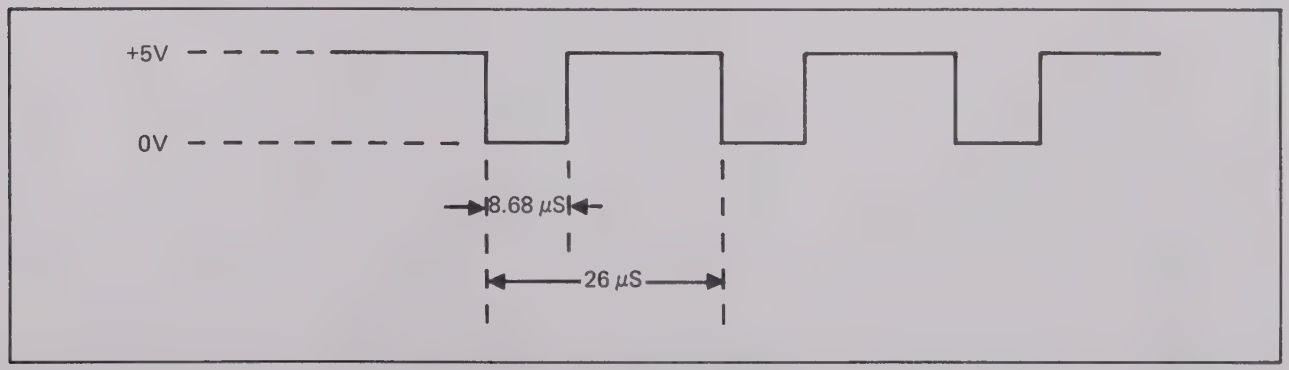


Figure 602-2. TP2, Clock Output Waveform

602-19. Clock circuit output drives both the ripple counter baud rate generator and the -10V dc power supply. The binary ripple counter divides the 38.4 kHz clock frequency to generate the following baud rate clocks:

19.2 kHz; 1200 baud
9.6 kHz; 600 baud
4.8 kHz; 300 baud
2.4 kHz; 150 baud

602-20. The 110 baud rate is generated by routing the 1200 baud signal through a divide-by-11 circuit consisting of four flip-flop circuits and a gate. The gate decodes flip-flop outputs and provides a 110 baud rate clock of 1745.45 Hz. This frequency, 1745.45 Hz, is 0.83% low. If a more accurate 110 baud is required, clock time may be adjusted, through the clock circuit potentiometer, to provide a 110 baud rate of 1760 Hz. However, all other baud rates will then be 0.83% high.

602-21. Switch positions 1 through 5 of S1 select the proper baud rate. Closing a switch position routes the selected baud clock frequency to the UART clock input. Only one switch position may be closed at one time.

602-22. As previously mentioned, the clock circuit drives the power supply. Refer to Figure 602-3, Power Supply Simplified Schematic. The -10V dc power supply is a flyback type. The first transistor is switched on and off by the clock pulse; the second transistor is controlled by the first. The second transistor remains on twice as long as it remains off. Energy stored in the inductor, while the second transistor is on, is transferred to the output when that transistor is off. The output voltage (Eo) is equal to the input voltage (+5V = EIN) multipled by time-on divided by time-off. Time-on divided by time-off is 2, due to the clock pulse duty cycle (33%), therefore, with a +5V input, the output voltage is a nominal -10V dc. This may be expressed as:

$$EO = -\frac{EIN \times tON.}{tOFF.}$$

602-23. MAINTENANCE

602-24. Refer to Section 4 of this manual for service information, cleaning instructions and general maintenance instructions.

602-25. Performance Test

602-26. Proper operation of the RS-232-C Interface can best be verified under actual operating conditions. Install the RS-232-C Interface in a known good 2020A Printer, and connect it to a known good input instrument. Compare the printer output to the input instrument indication.

602-27. Calibration Adjustment

602-28. Only one calibration adjustment is possible on the RS-232-C Interface. Potentiometer R1 adjusts the clock output frequency. Use the following procedure to adjust potentiometer R1.

1. Connect an accurate frequency counter to TP2.
2. Adjust R1 to obtain a clock output of 38.4 kHz.

602-29. Troubleshooting

602-30. Troubleshooting information presented in Table 602-4 is intended as a guide to assist in malfunction isolation. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision is required, perform the next step on the table in sequence.

602-31. LIST OF REPLACEABLE PARTS

602-32. A list of replaceable parts for the RS-232-C Interface is given in Table 602-5. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

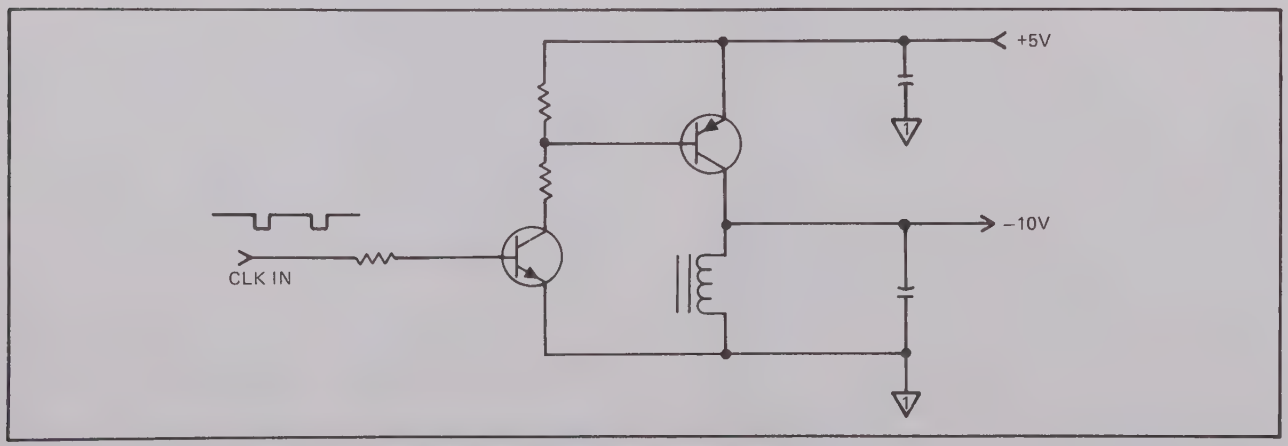


Figure 602-3. Power Supply Simplified Schematic

Table 602-4. RS-232-C Interface Troubleshooting Guide

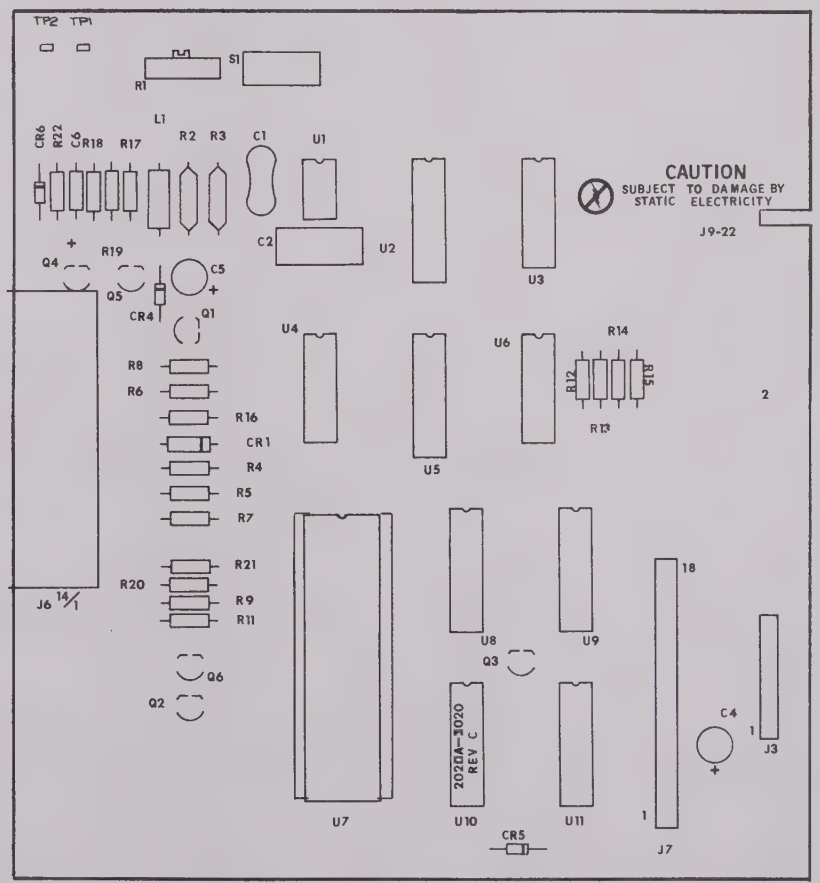
STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Is the baud rate selection switch (S1) in the proper position?	3	2
2	Place the switch in the proper position.		
3	Are baud rate pulses present at UART RCP input?	4	12
4	Are data pulses present at UART RRI input?	6	5
5	Check the Schmitt trigger and Clear to Send circuits.		
6	Does data transfer into the FIFO?	8	7
7	Check the UART.	8	7
8	Does data transfer out of the FIFO?		
9	Check the FIFO, the reset circuit and the output gate.	10	9
10	Is a PRINT command generated when a Single, Continuous, or Interval print signal is present?		
11	Check the PRINT circuit.	16	11
12	Are clock pulses present at TP2?		
13	Check the ripple counter and switch, S1.	13	14
14	Check the clock and associated circuitry.		
15	Check the −10 volt power supply output.		
16	Troubleshooting is complete. Disconnect all test equipment.		

Table 602-5. RS-232-C Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	⊗RS232 INTERFACE PCB ASSEMBLY FIGURE 602-4 (2020A-4020)	ORDER	BY	OPTION -002			
C1	CAP, MICA, 1000 PF +/-1%, 500V	217844	72136	DM19F102F	1		
C2	CAP, PLYSTR, FLM 0.10 UF +/-10%, 250V	325548	73445	C280MAE/A10K	1		
C4	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	2		
C5	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	REF		
C6	CAP, TA, ELECT, 3.3 UF +/-10%, 15V	182808	56289	150D335X9015A2	1		
CR1	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	2	1	
CR4	DIODE, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR5	DIODE, GE (GLASS) 250 MA	149187	22767	1N270	1		
CR6	DIODE, ZENER	249052	07910	1N963B	1		
H1	HARDWARE KIT (TO J6, NOT SHOWN)	448092	71785	318-15-99-058	2		
H2	SCREW, THRD/FORM (UNDER J6, NOT SHOWN)	501114	89536	501114	2		
J3	CONNECTOR, RECEPTACLE, POST	267476	00779	85861-2	8		
J6	CONNECTOR, RECEPTACLE, 25-PIN	461996	00779	206584-1	1		
J7	CONNECTOR, SOCKET, 18-PIN	435024	00779	583773-8	1		
L1	INDUCTOR, SUB-MINI, SHLD	363184	24759	MR6800	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	4	1	
Q2	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q3	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q4	XSTR, SI, PNP	195974	04713	2N3906	2	1	
Q5	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q6	XSTR, SI, PNP	195974	04713	2N3906	REF		
R1	RES, VAR, CERMET, 2K +/-10%, 1/2W	285163	11236	360S-102A	1	1	
R2	RES, MTL. FILM, 14.3K +/-1%, 1/8W	291617	91637	CMF551432F	1		
R3	RES, MTL. FILM, 8.45K +/-1%, 1/8W	221671	91637	CMF558451F	1		
R4	RES, DEP. CAR, 300 +/-5%, 1/4W	441519	80031	CR251-4-5P300E	4		
R5	RES, DEP. CAR, 300 +/-5%, 1/4W	441519	80031	CR251-4-5P300E	REF		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	7		
R7	RES, DEP. CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9	2		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	2		
R11	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R13	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R14	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R15	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R16	RES, DEP. CAR, 300 +/-5%, 1/4W	441519	80031	CR251-4-5P300E	REF		
R17	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R18	RES, DEP. CAR, 680 +/-5%, 1/4W	368779	80031	CR251-4-5P680E	1		
R19	RES, DEP. CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2	1		
R20	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R21	RES, DEP. CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9	REF		
R22	RES, DEP. CAR, 300 +/-5%, 1/4W	441519	80031	CR251-4-5P300E	REF		
S1	SWITCH, SPST, DIP	454769	00779	435802-4	1		
U1	IC LINEAR TIMER	402610	12040	LM555CN	1	1	
U2⊗	IC, C-MOS, DUAL J-K MASTER SLAVE F/F	355230	12040	CD4027BCN	2	1	
U3⊗	IC, C-MOS, 7-STAGE BINARY COUNTER	412965	12040	CD4024AE	1	1	
U4⊗	IC, C-MOS, NOR GATE QUAD, 2-INPUT	355172	12040	CD4001AE	1	1	

Table 602-5. RS-232-C Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U5Ⓧ	IC, C-MOS, DUAL J-K MASTER SLAVE F/F	355230	12040	CD4027BCN	REF		
U6Ⓧ	IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	12040	CD4023CN	1	1	
U7Ⓧ	IC, C-MOS, ASYNCRNS,' REC/TRANSMITTER	453464	32293	IM6402CPL	1	1	
U8Ⓧ	IC, C-MOS, FIFO RGSTR, 4-BITS	495200	02735	CD40105BE	4	1	
U9Ⓧ	IC, C-MOS, FIFO RGSTR, 4-BITS	495200	02735	CD40105BE	REF		
U10Ⓧ	IC, C-MOS, FIFO RGSTR, 4-BITS	495200	02735	CD40105BE	REF		
U11Ⓧ	IC, C-MOS, FIFO RGSTR, 4-BITS	495200	02735	CD40105BE	REF		
XU7	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		



2020A-1620

Figure 602-4. RS-232-C Interface PCB Assembly

Option -003
IEEE-488 Interface

603-1. INTRODUCTION

603-2. Interface Option -003 is an IEEE-488 interface logic network capable of accepting bit-parallel, character-serial ASCII information from the IEEE-488 Standard Bus. Data may be accepted in either of two switch selectable modes: the Listen Only mode (S2 ON), in which the interface accepts all bus data, and the Addressable mode (S2 OFF), in which the interface accepts data only when addressed by the bus controller. In either input mode, the interface transfers ASCII data to the 2020A Printer using a handshake mode.

603-3. The IEEE-488 Interface is either factory or field installable. It is compatible with all other Fluke instruments using IEEE-488 Interfaces, and it is compatible with 2020A Option -006, the Interval Timer Option. The character set consists of the standard 64 upper-case ASCII characters, plus the special characters shown in Table 603-1. All control and data information is exchanged through a 24-pin female connector. Refer to Table 603-2 for connector pin usage information.

603-4. SPECIFICATIONS

603-5. All temperature, humidity, vibration, and power specifications listed for the 2020A Printer are also valid when the IEEE-488 Interface is installed in the printer. Additional specifications applicable only to the IEEE-488 Interface are listed in Table 603-3.

603-6. INSTALLATION

603-7. To install or exchange input interface options, use the following procedure:

1. Disconnect all 2020A power and signal connections.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear by pulling straight up.

NOTE

Steps a and b are necessary only if the 2020A Printer is equipped with Interval Timer Option -006.

Table 603-1. Special Printer Characters

ASCII CODE CHARACTER	PRINTER CHARACTER
Control J (Line Feed)	Terminate Input String
Control L (Form Feed)	Space One Line
Control P	Initiate Plot Mode
Decimal 254	Advance Paper
Decimal 255	Terminate Plot Mode
Lower Case d	Degree Symbol (°)
Lower Case f	Lower Case f
Lower Case k	Lower Case k
Lower Case m	Lower Case m
Lower Case n	Lower Case n
Lower Case p	Lower Case p
Lower Case r	Omega Symbol (Ω)
Lower Case s	Lower Case s
Lower Case u	Micro Symbol (μ)
Lower Case z	Lower Case z

Table 603-2. Connector Pin Usage

INPUT CONNECTOR (J6) PIN NUMBER	MNEMONIC	SIGNAL DESCRIPTION
J6 - Pin 1	DIO1	Bit Parallel, Byte Serial Data: Bit 1
J6 - Pin 2	DIO2	Bit Parallel, Byte Serial Data: Bit 2
J6 - Pin 3	DIO3	Bit Parallel, Byte Serial Data: Bit 3
J6 - Pin 4	DIO4	Bit Parallel, Byte Serial Data: Bit 4
J6 - Pin 5	EOI	End or Identify: Not Used
J6 - Pin 6	DAV	Data Valid: from Bus Controller
J6 - Pin 7	NRFD	Not Ready for Data: from Interface
J6 - Pin 8	NDAC	Not Data Accepted: from Interface
J6 - Pin 9	IFC	Interface Clear: from Bus Controller
J6 - Pin 10	SRQ	Service Request: Not Used
J6 - Pin 11	ATN	Attention: from Bus Controller
J6 - Pin 12		
J6 - Pin 13	DIO5	Bit Parallel, Byte Serial Data: Bit 5
J6 - Pin 14	DIO6	Bit Parallel, Byte Serial Data: Bit 6
J6 - Pin 15	DIO7	Bit Parallel, Byte Serial Data: Bit 7
J6 - Pin 16	DIO8	Bit Parallel, Byte Serial Data: Bit 8
J6 - Pin 17	REN	Remote Enable: Not Used
J6 - Pin 18-24	—	Bussed to Digital COMMON
PRINTER CONNECTOR (J7) PIN NUMBER	**MNEMONIC**	**SIGNAL DESCRIPTION**
J7-2	RESET	RESET COMMAND: from 2020A Printer
J7-3	DR	DATA READY: from Interface
J7-4	PRINT	PRINT COMMAND: from Interface
J7-5	ASCII 0	ASCII DATA 0: from Interface
J7-6	ASCII 1	ASCII DATA 1: from Interface
J7-7	ASCII 2	ASCII DATA 2: from Interface
J7-8	ASCII 3	ASCII DATA 3: from Interface
J7-9	ASCII 4	ASCII DATA 4: from Interface
J7-10	ASCII 5	ASCII DATA 5: from Interface
J7-11	ASCII 6	ASCII DATA 6: from Interface
J7-12	ASCII 7	ASCII DATA 7: from Interface
J7-13	GND 1	Digital COMMON: from Printer
J7-14	PRINTING	Printing Signal: from Printer
J7-15	ACK	Acknowledge Data Received: from Printer
J7-16	+5	+5V dc: from Printer
J7-17	SINGLE	Single Print Command: from Printer
J7-18	CONT	Continuous Print Command: from Printer

Table 603-3. IEEE-488 Specifications

Input Connector	24-pin female
Signals	IEEE-488 1978 STD
Scan Capability	None
Plug Compatible	All other IEEE-488 1978 STD
Character Set	64 Upper case ASCII, plus special characters
IEEE Mode	Listen Only or Addressed Listen; Switch selectable
Buffer Storage	None

a. Remove the retaining screws and pull the rear edge of the Interval PCB up to disconnect it from the interface pcb.

b. Pull the Interval PCB toward the rear of the 2020A Printer to disconnect it from the Keyboard PCB.

4. Remove the single screw at the front of the interface pcb and the two screws securing the connector to the 2020A Printer rear panel.

5. Disconnect the ribbon cable between the interface pcb and the 2020A Printer PCB, then remove the interface pcb.

6. To reinstall the interface pcb, first reconnect the ribbon cable between the interface and the 2020A Printer PCB.

7. Position the interface pcb and install the three retaining screws. (One at the front and two securing the input connector.)

NOTE

Reinstall the Interval Timer PCB if necessary.

8. Replace the 2020A Printer cover.

9. Replace the four cover retaining screws in the bottom of the 2020A Printer case.

603-8. OPERATION

603-9. Model 2020A Printer operating instructions, given in Section 2, are valid for Model 2020A Printers with the IEEE-488 Interface installed. If the Interval Timer Option is also installed, refer to Option -006 shown later in this section for supplemental operating instructions.

603-10. THEORY OF OPERATION

603-11. Overall Theory

603-12. The IEEE-488 Interface is an IEEE-488 listener device only. A typical IEEE-488 system bus structure is shown in Figure 603-1; the 2020A IEEE-488 Interface is equivalent to device C. The interface may accept data from the bus in either of two ways: it may receive all bus data, or it may receive data only when it is addressed. Constant listen or addressed listen operation is established by the operator through a switch located on the IEEE-488 Interface PCB.

603-13. Three types of inputs from the IEEE-488 bus structure are required by the interface. They are: General Interface Management signals, Data Byte Transfer Control signals, and input data from the Data Bus. The IEEE-488 bus structure supplies five General Interface Management lines, but the interface circuitry uses only two: IFC and ATN. The three Data Byte Transfer Control lines are used as handshake lines for data transfer. The Data Bus (eight lines) supplies input data, and, in the addressable operating mode, it also supplies an address to the input interface from the system bus controller.

603-14. Within the IEEE-488 Interface, four functional circuitry groups control data transfer from the IEEE Bus to the Printer PCB. These functional circuit groups are: data line buffers, control line buffers, address logic and control, and the handshake logic and control. As can be seen in Figure 603-2, the data transfer path is directly from the IEEE Bus, through the data line buffers, to the Printer PCB. Data transfer control necessitates control line buffers, address logic and control, and handshake logic and control circuitry.

603-15. Block Diagram Analysis

603-16. Either a Listen Only or Addressable Listen operating mode may be established by switch selection on the interface board. A switch, S2, functionally located within the address logic, is used to select the operating mode. With S2 on, Listen Only operation is selected, and the interface will accept and transfer all data on the IEEE Bus. If switch S2 is off, or open, Addressable Listen operation is established, and the interface will accept and transfer data only when it receives a valid address on the data lines.

603-17. A second switch, S1, can establish any of 31 possible valid interface addresses in the Addressable Listen mode. An address code established through the five-segment switch (S1) is routed to a group of address gates through buffers. When the IEEE-488 Interface receives a Data Bus input identical to the address code

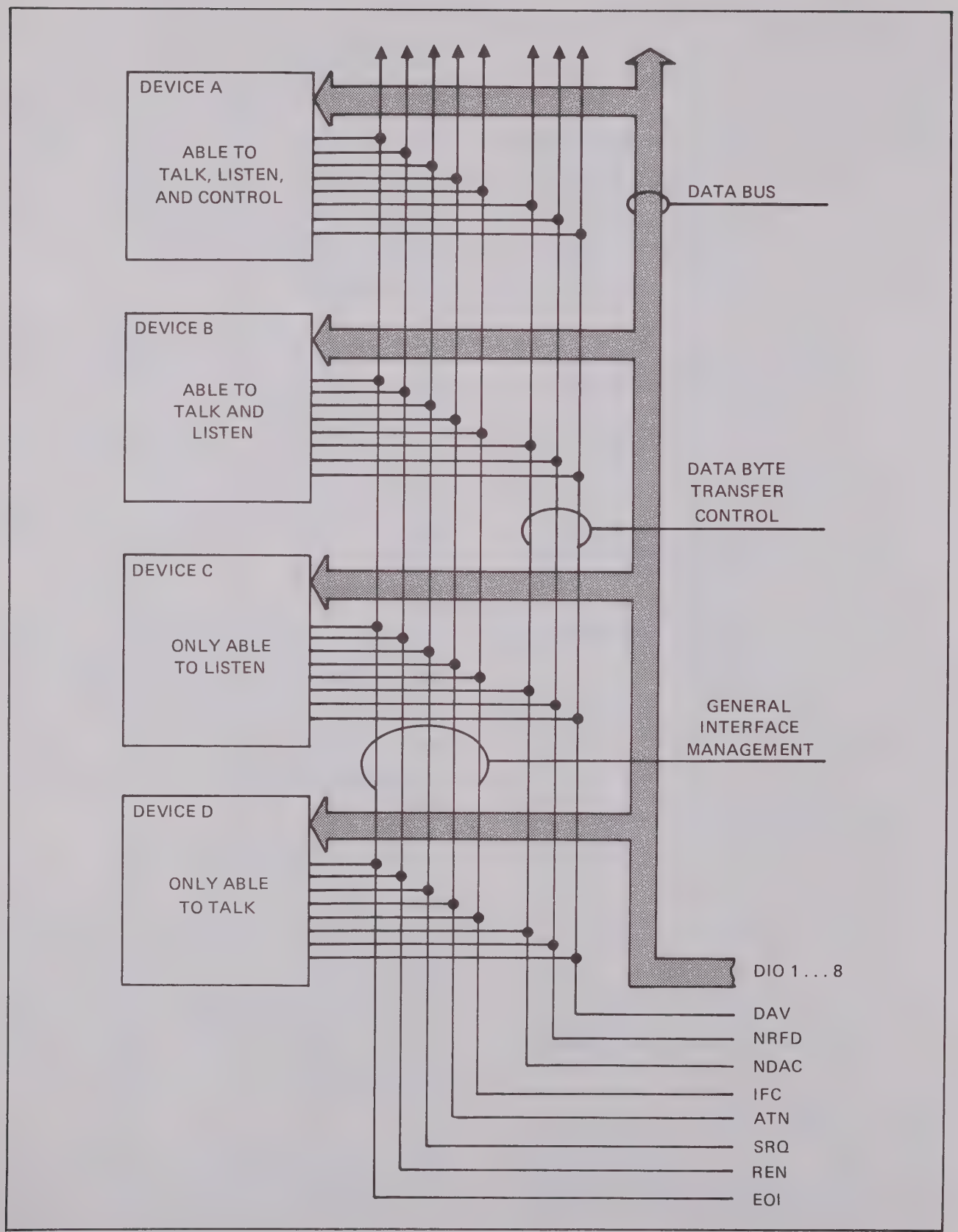


Figure 603-1. Typical IEEE-488 Bus Structure

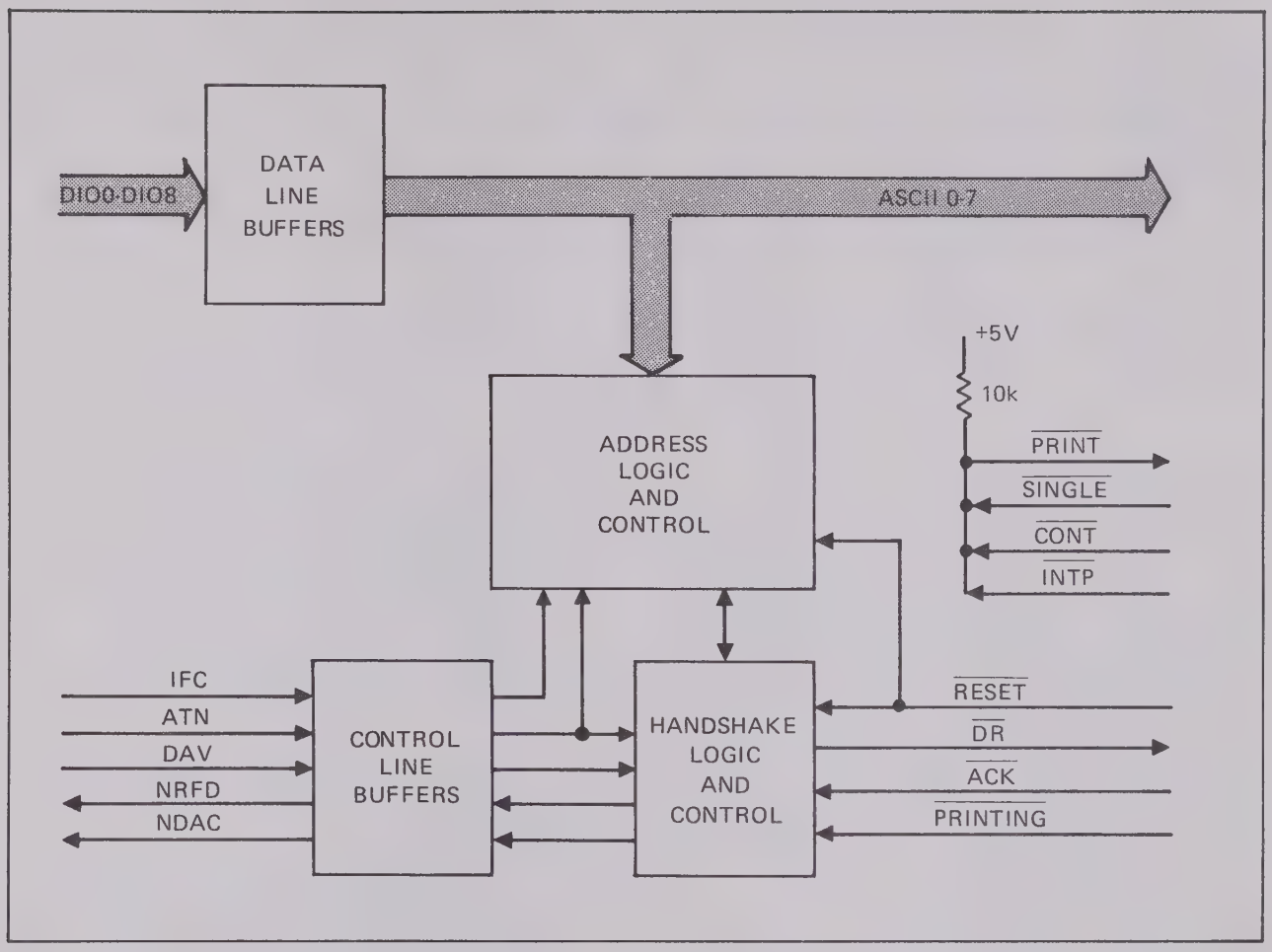


Figure 603-2. IEEE-488 Interface Block Diagram

selected through switch S1, the Data Bus input and address code are coincident at the gates, and produce a logic high MLA (My Listen Address) output. If the IEEE Bus IFC (Interface Clear) input is false (high) and ATN (Attention) is true (low), the MLA high level signal, through the additional address logic, produces a low logic level LA (Listener Addressed) input to an OR gate. This OR gate output enables the DR (Data Ready) line in the handshake logic when the IEEE ATN (Attention) input is high.

603-18. To return the interface address logic to an unaddressed condition, a UNL (Unlisten) signal is generated through the address logic when an UNL code is received on the IEEE Data Bus. The UNL signal disables address logic gating, thereby, removing the low level LA input, and disabling the DR output.

603-19. Data byte transfer control lines shown in Figure 603-1, are used for handshake data transfer from the IEEE Bus to the interface. As shown in Figure 603-3, a handshake data transfer is initiated when the interface handshake logic sets NRFD (Not Ready For Data) high (false), indicating it is ready to receive data. After detecting a high level on the NRFD line, the IEEE "talker" will set DAV (Data Available) low. When DAV goes low, interface handshake logic transfers the data and sets NDAC (Not Data Accepted) high, indicating data has been accepted. Data is transferred from the IEEE-488 Interface to the Printer PCB using the DR and ACK lines as described in Section 3 of this manual.

603-20. Only two of the five General Interface Management lines shown in Figure 603-1 are used in the IEEE-488 Interface. The IFC (Interface Clear) and ATN (Attention) lines are used; the REN, SRQ, and EOI lines are terminated within the interface. When the IFC line goes to a low logic state, it clears all existing address logic states. The address logic returns to an idle (reset) condition and awaits the next valid address code on the Data Bus lines.

603-21. The ATN line performs control functions in both the address logic and the handshake logic circuits. When the ATN line is at a low logic level, the address logic is enabled to respond to the Data Bus address codes. The ATN low condition, however, disables the DR handshake line through the handshake logic circuitry. After the

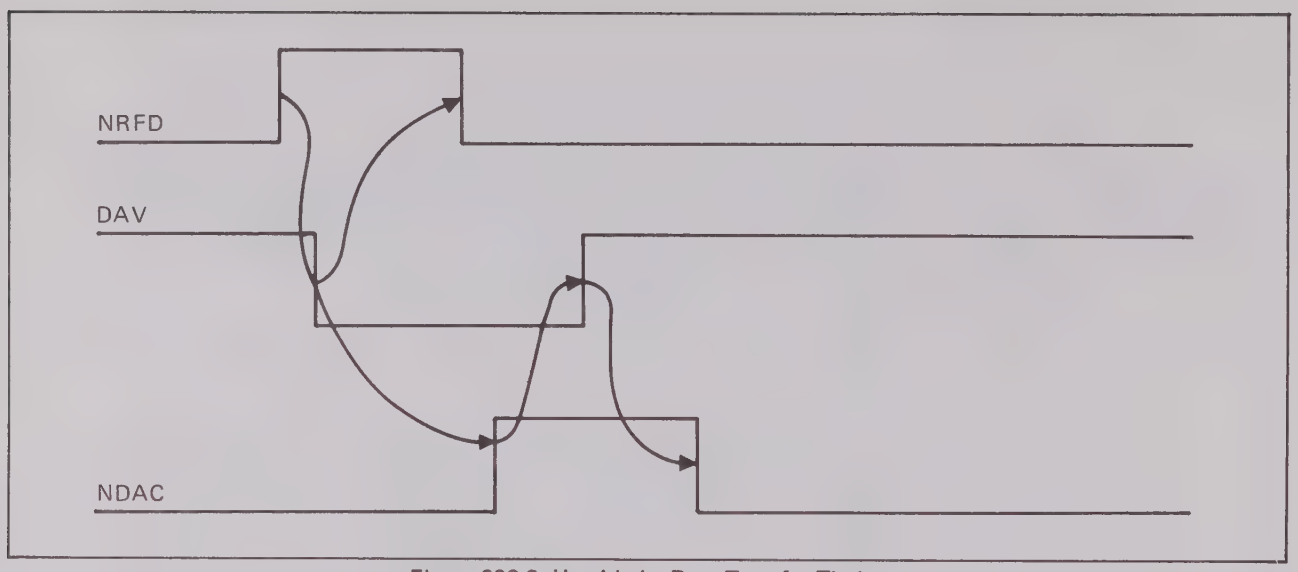


Figure 603-3. Handshake Data Transfer Timing

address logic has received a valid address code and entered an addressed condition, the ATN line may return to a high logic state. Handshake logic is enabled with ATN high, and data may be transferred through the IEEE-488 Interface. The UNL circuit within the address logic is also enabled by ATN low and will respond to a UNL Data Bus code. If the interface receives an Unlisten code, or if the IFC line resets the address logic, ATN must go to a low logic state before the interface may again respond to a valid address code.

603-22. MAINTENANCE

603-23. Refer to Section 4 of this manual for service information, cleaning instructions, and general maintenance instructions.

603-24. Performance Test

603-25. Proper IEEE-488 Interface operation can best be verified with the interface pcb installed in a 2020A Printer. Two test methods are possible, depending on the availability of either an IEEE-488 "talker" input instrument or an IEEE-488 controller. A test software routine written for the applicable IEEE-488 controller provides a thorough test of all functions with the IEEE-488 Interface in the addressable mode (S2 open). Since a software test routine is controller dependent, it must be user supplied.

603-26. The second, or alternative, method of testing the IEEE-488 Interface involves use of an IEEE-488 "talker" instrument. With the interface pcb installed in a 2020A Printer and switch S2 closed to establish the Listener Only operating mode, the handshake logic and data buffers can be tested, but the address logic cannot be tested.

603-27. To test the IEEE-488 Interface Assembly using an IEEE-488 "talker" instrument, use the following procedure:

1. Set the IEEE-488 "talker" instrument to a talk only mode.

2. Set S2 on the interface pcb to the closed or ON position.

3. Install the IEEE-488 Interface PCB in a 2020A Printer, and connect the IEEE-488 "talker" instrument.

4. Initiate a 2020A Printer print cycle and compare the information printed to that displayed on the "talker" instrument. If the printed information and displayed information correspond, the handshake and data tranfer circuits in the IEEE-488 Interface are working properly.

603-28. Calibration Adjustments

603-29. The IEEE-488 Interface does not require periodic or post-repair calibration adjustments.

603-30. Troubleshooting

603-31. Troubleshooting information presented in Table 603-4 is intended as a guide to assist in malfunction isolation. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision is required, perform the next step in the table in sequence.

603-32. LIST OF REPLACEABLE PARTS

603-33. A list of replaceable parts for the IEEE-488 Interface is given in Table 603-5. Refer to Section 5 of this manual for ordering information.

CAUTION

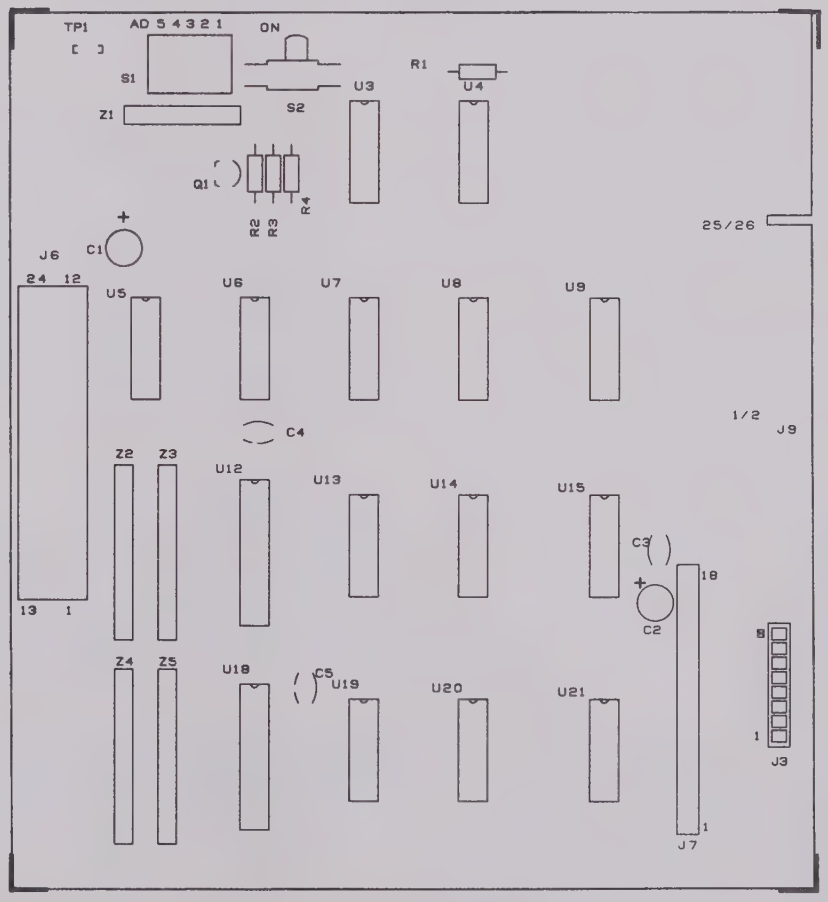
Indicated devices are subject to damage by static discharge.

Table 603-4. IEEE-488 Interface Assembly Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Does IEEE-488 Interface operate in Listen Only mode (S2 closed)?	5	2
2	Are correct handshake signals present?	4	3
3	Check handshake circuit components (U3, 4, 5, 6, 7, 8).		
4	Check data buffer circuit components (U18, 13).		
5	Does IEEE-488 Interface operate in addressable mode (S2 open)?	16	6
6	Is address switch (S1) set to proper address?	8	7
7	Reset the address switch, or reprogram the controller, to the proper address.		
8	Does address decode circuit produce an MLA signal?	10	9
9	Check address decode circuit components (U12, 13).		
10	Is UNL signal true?	11	12
11	Check UNL decoder circuit (U19, 15) if UNL command has not been programmed.		
12	Does Listener State Logic produce a LA signal?	14	13
13	Check Listener State Logic components (U9, 21, 15).		
14	Are correct handshake signals present?	16	15
15	Check handshake circuit components (U3, 4, 5, 6, 7, 8).		
16	IEEE-488 Interface troubleshooting is complete.		

Table 603-5. IEEE-488 Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	IEEE-488 INTERFACE PCB ASSEMBLY FIGURE 603-4 (2020A-4030)	ORDER	BY	OPTION -003			
C1	CAP, TA, 0.47 UF +/-20%, 35V	161349	56289	196D474X0035HA1	1		
C2	CAP, TA, 39 UF %, 6V	163915	56289	196D396X0006KA1	1		
C3	CAP, CER, 0.01 UF -20/+80%, 25V	335786	72982	5835-000-Y5V-103Z	3		
C4	CAP, CER, 0.01 UF -20/+80%, 25V	335786	72982	5835-000-Y5V-103Z	REF		
C5	CAP, CER, 0.01 UF -20/+80%, 25V	335786	72982	5835-000-Y5V-103Z	REF		
H1	HARDWARE KIT, (TO J6, NOT SHOWN)	494773	00779	552633-4	1		
H2	SCREW, THRD/FORM (UNDER J6, NOT SHOWN)	448456	89536	448456	2		
J3	CONNECTOR, RECEPTACLE, POST	267476	00779	85861-2	8		
J6	CONNECTOR, RECEPTACLE, 24-PIN	500884	00779	552791-1	1		
J7	CONNECTOR, SOCKET, 18-PIN	435024	00779	583773-8	1		
MP1	ADAPTER, CONNECTOR (ON J6, NOT SHOWN)	479321	89536	479321	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	2		
R2	RES, DEP. CAR, 1.6K +/-5%, 1/4W	348805	80031	CR251-4-5P1K6	1		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R4	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	1		
S1	SWITCH SPST, DIP	454769	00779	435802-4	1		
S2	SWITCH, SLIDE	453365	89536	453365	1		
U3	IC, TTL, QUAD, 2-INPUT, POS NAND GATES	393033	01295	SN74LS00N	4	1	
U4	IC, TTL, QUAD, 2-INPUT, POS NAND GATES	393033	01295	SN74LS00N	REF		
U5	IC, TTL, QUAD, 2-INPUT, POS NAND GATES	310201	01295	SN7438N	1		
U6	IC, TTL, QUAD, 2-INPUT, POS NAND GATES	393033	01295	SN74LS00N	REF		
U7	IC, TTL, TRIPLE 3-INPUT POS NAND GATES	393074	01295	SN74LS10N	3	1	
U8	IC, TTL, TRIPLE 3-INPUT POS NAND GATES	393074	01295	SN74LS10N	REF		
U9	IC, TTL, QUAD, 2-INPUT, POS AND GATES	393066	01295	SN74LS08N	1	1	
U12	IC, OCTAL-BFRS, LINE-DRVRS, 3-ST/OUTPUT	429480	01295	SN74LS240N	2	1	
U13	IC, LO-PWR SCHTKY, QUAD 2-INPUT EX NOR-G	393272	01295	SN74LS266N	2	1	
U14	IC TTL, HEX, INVERTER, POS NAND GATES	393058	01295	SN74LS04	1	1	
U15	IC, TTL, QUAD, 2-INPUT, POS NAND GATES	393033	01295	SN74LS00N	REF		
U18	IC, OCTAL-BFRS, LINE-DRVRS, 3-ST/OUTPUT	429480	01295	SN74LS240N	REF		
U19	IC, TTL, 8-INPUT POS NAND GATES	404889	01295	SN74LS30N	1	1	
U20	IC, LO-PWR SCHTKY, QUAD 2-INPUT EX NOR-G	393272	01295	SN74LS266N	REF		
U21	IC, TTL, TRIPLE 3-INPUT POS NAND GATES	393074	01295	SN74LS10N	REF		
Z1	RES, NETWORK, 10K	500876	89536	500876	1	1	
Z2	RES, NETWORK, 3K	501528	89536	501528	2	1	
Z3	RES, NETWORK, 6.2K	501536	89536	501536	2	1	
Z4	RES, NETWORK, 3K	501528	89536	501528	REF		
Z5	RES, NETWORK, 6.2K	501536	89536	501536	REF		



2020A-1630

Figure 603-4. IEEE-488 Interface PCB Assembly

Option -004
PTI Interface

604-1. INTRODUCTION

604-2. The PTI Interface, Option -004, is intended to accept data directly from other Fluke instruments in either a BCD or ASCII format. Two data transfer modes can be used: handshake data transfer for ASCII format data, and clocked data transfer for BCD format data. The interface will accept and transfer data from a maximum of nine addressable input instruments. It will also scan all channels of a Model 2300 Scanner.

604-3. Communication with the PTI (Portable Test Instrument) Interface is through a 36-pin Amp ("Champ" Series) male connector. Data is received on eight data lines; input instruments are addressed through four address lines; and the handshake data transfer mode requires an additional four lines. Refer to Table 604-1 for connector pin usage information.

604-4. The printer character set consists of the 64 upper-case ASCII characters, plus the special characters listed in Table 604-2. Table 604-3 lists the applicable addresses, instruments and interface modes.

604-5. SPECIFICATIONS

604-6. The PTI Interface meets all temperature, humidity, vibration, and power specifications listed for the 2020A Printer. Additional specifications applicable to the PTI Interface are listed in Table 604-4.

604-7. INSTALLATION

604-8. To install or exchange interface options, use the following procedure:

1. Disconnect all 2020A power and signal connections.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear of the unit by pulling straight up.

Table 604-1. Input Connector Pin Assignments

PIN NO.	MNEMONIC	DESCRIPTION
1	$\overline{\text{ADRVL}}$	Address Valid
2	$\overline{\text{DATVL}}$	Data Valid
3	A0	Instrument Address, LSB
4	A1	Instrument Address, 2SB
5	A2	Instrument Address, 3SB
6	A3	Instrument Address, MSB
7	$\overline{\text{DTACK}}$	Data Acknowledge
8	$\overline{\text{SCNIP}}$	Scan In Progress
9	D0	LSB (Input Data Lines)
10	D1	2SB
11	D2	3SB
12	D3	4SB
13	D4	5SB
14	D5	6SB
15	D6	7SB
16	D7	MSB
17	GND	Common Return
18	+5	Supplied by printer
19-36	---	Not used by printer

Table 604-2. Special Printer Characters

ASCII CODE CHARACTER	PRINTER CHARACTER
Control J (Line Feed)	Terminate Input String
Control L (Form Feed)	Space One Line
Control P	Initiate Plot Mode
Decimal 254	Advance Paper
Decimal 255	Terminate Plot Mode
Lower Case d	Degree Symbol (°)
Lower Case f	Lower Case f
Lower Case k	Lower Case k
Lower Case m	Lower Case m
Lower Case n	Lower Case n
Lower Case p	Lower Case p
Lower Case r	Omega Symbol (Ω)
Lower Case s	Lower Case s
Lower Case u	Micro Symbol (μ)
Lower Case z	Lower Case z

Table 604-3. PTI Interface Addresses

ADDRESS		DATA FORMAT	INTERFACE MODE
BINARY	HEX		
0000	0	None	PTI System RESET
0001	1	Parallel ASCII	Handshake
0010	2	7250A, 7260A, 7261A	Clocked
0011	3	7220A	Clocked
0100	4	8920A	Clocked
0101	5	8600A, 8800A	Clocked
0110	6	Parallel ASCII	Handshake
0111	7	Parallel ASCII	Handshake
1000	8	Parallel ASCII	Handshake
1001	9	Parallel ASCII	Handshake
1111	F	None	All instruments OFF

Table 604-4. PTI Interface Specifications

Connector	Male 36-pin Amp "Champ"
Input Signals	8 Data Lines
Output Signals	4 Address Lines
Handshake Signals	$\overline{\text{ADRVL}}$, $\overline{\text{SCNIP}}$, $\overline{\text{DTACK}}$, $\overline{\text{DTVL}}$
Scan Capability	Maximum of 9 PTI Addressable instruments or all 2300 Scanner channels.
Annotation	Instrument address. Elapsed time only with Option -006).
Character Set	64 Upper-case ASCII plus special characters - Table 604-2.
Plug Compatible	7250A, 7260A, 7261A, 7220A Fluke Counters. 8600A, 8800A, 8920A Fluke DVMs. 2180A, 2190A Fluke Thermometers
Buffer Storage	One line.

NOTE

Steps a and b are necessary only if the 2020A Printer is equipped with Interval Timer, Option -006.

a. Remove the retaining screws and pull the rear edge of the Interval PCB up to disconnect it from the interface pcb.

b. Pull the Interval PCB toward the rear of the 2020A Printer to disconnect it from the Keyboard PCB.

4. Remove the single screw at the front of the interface pcb and the two screws securing the connector to the 2020A Printer rear panel.

5. Disconnect the ribbon cable between the interface pcb and the 2020A Printer PCB then remove the interface pcb.

6. To reinstall the interface pcb, first reconnect the ribbon cable between the interface pcb and the 2020A Printer PCB.

7. Position the interface pcb and install the three retaining screws. (One at the front and two securing the input connector.)

NOTE

Reinstall the Interval Timer PCB if necessary.

8. Replace the 2020A cover.

9. Replace the four cover retaining screws.

604-9. OPERATING INSTRUCTIONS

604-10. Model 2020A Printer operating instructions are valid for printers with the PTI Interface installed. If the Interval Timer is also installed, refer to the Interval Timer, Option -006, operating instructions.

604-11. THEORY OF OPERATION

604-12. Interface Signals

604-13. All interface signals between the PTI Interface and an input instrument are listed in Table 604-2. Address and data line logic levels are positive-true (≥3.5V); all handshake signals are negative-true (≤1.5V). High and low logic levels are based on standard "B" series CMOS requirements, for which the supply voltage is 5.5V dc maximum. All signals are active true.

604-14. Interface data lines (D0-D7) are tri-state lines through which the input instrument supplies data to the PTI Interface. These lines are enabled only when an input instrument receives its valid address. Input data format is instrument dependent, refer to Table 604-3.

604-15. Address lines (A0-A3) allow multiple instruments to be connected to one printer, and they are used by the printer to determine the type of instrument connected. Each input instrument enables its data lines (D0-D7) only when it receives a valid address on the address lines.

604-16. Four handshake data lines are used to transfer each character into the PTI Interface in the handshake transfer mode. When an input instrument receives a valid address on the address lines, it sends the Address Valid (ADRVL) line to a low logic level (≤.7V) to indicate it has been addressed. It then places valid data on the data lines (D0-D7) and sends the Data Valid (DATVL) line low. The interface reads and accepts the data then sends Data Acknowledge (DTACK) low to inform the input instrument that the data has been received. Data transfer is complete when the printer receives a 0A hex (ASCII Line Feed). Refer to Figure 604-1, Handshake Data Transfer Timing.

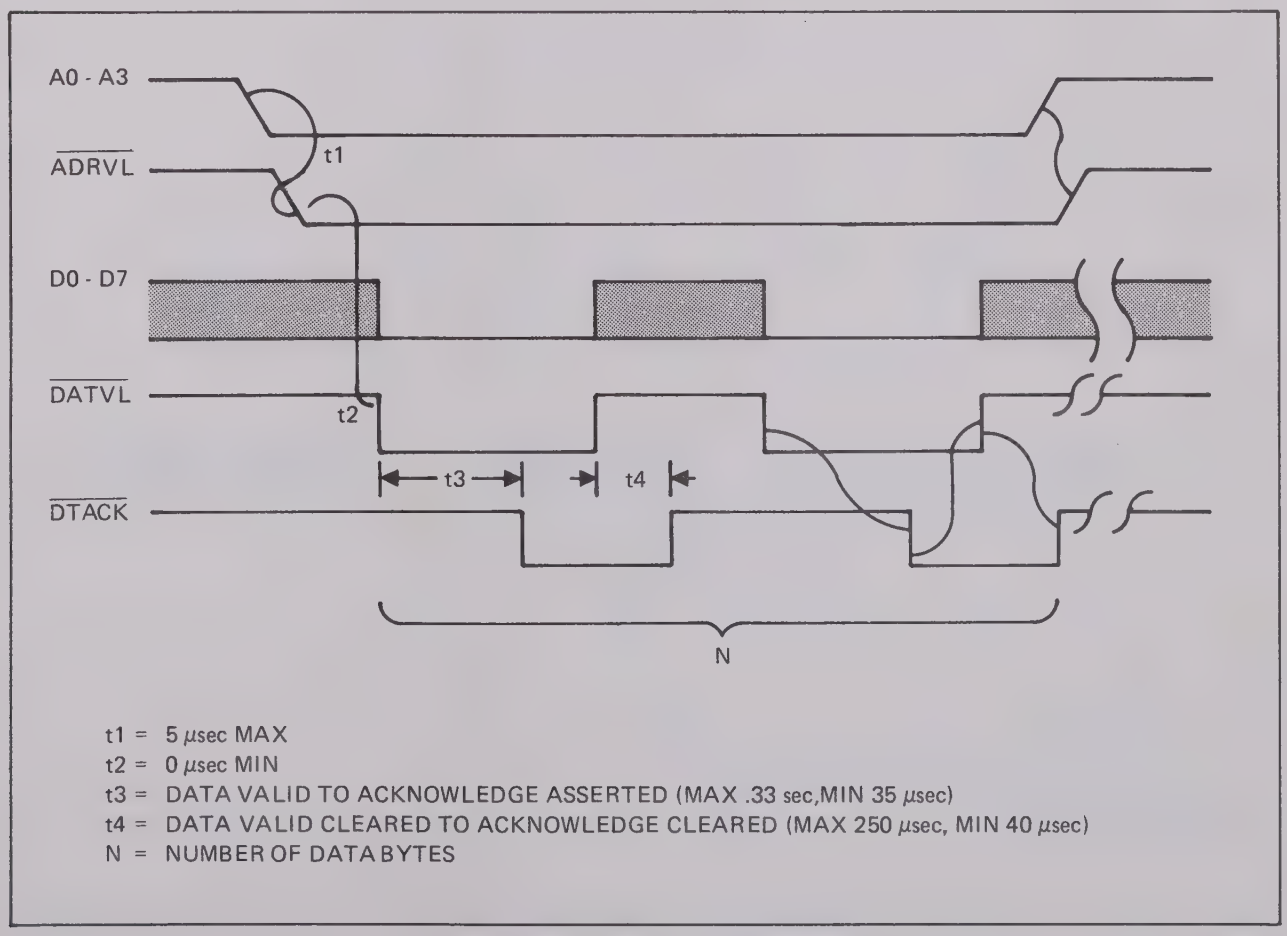


Figure 604-1. Handshake Data Transfer Timing

604-17. Clocked data transfer does not require a response from the PTI Interface. The input instrument receives a valid address, sends the ADRVL line low, places data on the data lines, and pulses the DATVL line low. This process is repeated to transfer each valid character. Data transfer is complete when the printer receives a number of pieces of data, with that number determined by the instrument address. Refer to Figure 604-2, Clocked Data Transfer Timing.

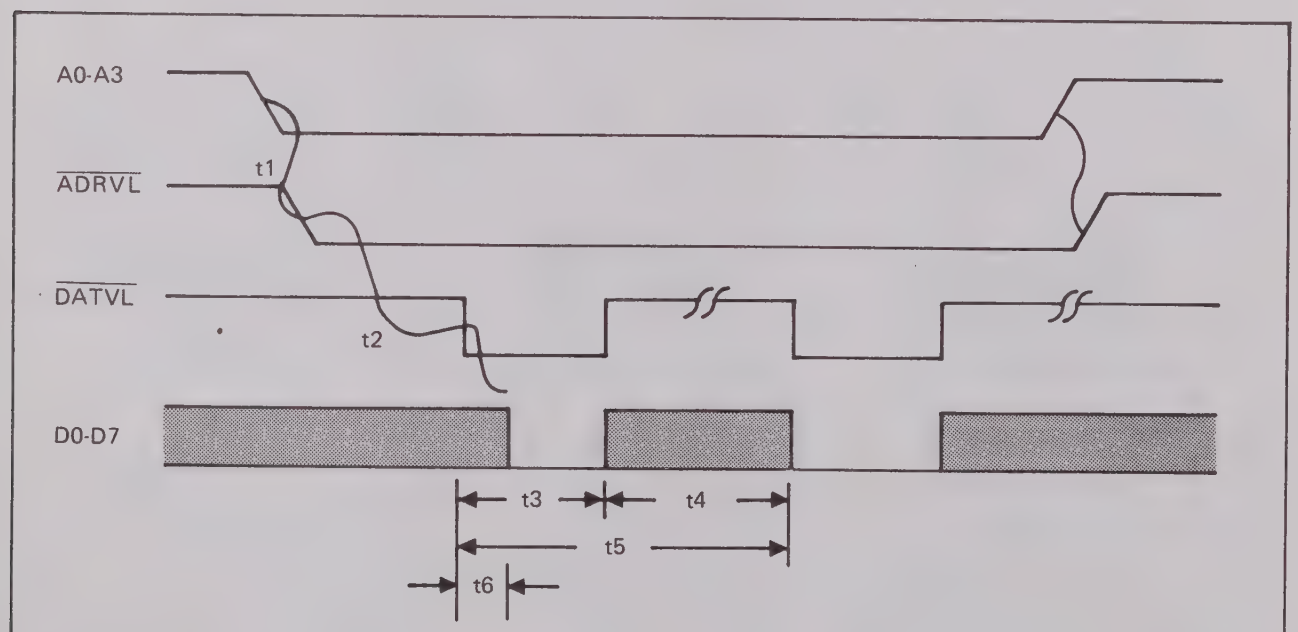
604-18. BCD data is accepted in any of four instrument dependent formats shown in Figure 604-3. Each group of Fluke instruments listed transfers BCD data in the format shown using the clocked data transfer mode.

604-19. Block Diagram Description

604-20. Interface circuitry on the PTI Interface comprises a data buffer, an address buffer, a handshake buffer, an output latch, a microcomputer, and some print signal gating. The interface also has a provision for installation of a special PROM if transform cases other than those in the microcomputer ROM are required. Refer to Figure 604-4, PTI Interface Block Diagram.

604-21. A polling sequence of all instruments connected to the Input Bus is initiated when the PTI Interface receives a single (SINGLE), continuous (CONT), or interval print command from the 2020A Printer PCB or the Interval Timer Option. A single print command initiates a single polling sequence; a continuous print command initiates continuous successive polling sequences; an interval print command initiates a single polling sequence at the operator selected time interval. In addition, the interval print (INTP) initiates an elapsed time print output from the microcomputer.

604-22. When any of the print inputs initiates a polling sequence, the microcomputer sends instrument address number 1 through the address buffers and out the address lines. If the ADRVL line goes true (low) within 5 μs, data is read in through the data buffer. If the ADRVL line remains false (high) more than 5 μs after the address is sent, the microcomputer increments to the next address and sends it.



t1 = 5 μsec max
t2 = 0 μsec minimum
t3 = Data Valid Asserted (Minimum 40 μsec)
t4 = Data Valid Not Asserted (Minimum 20 μsec)
t5 = 80 μsec minimum
t6 = 15 μsec maximum

Figure 604-2. Clocked Data Transfer Timing

(1) 7250, 7260, 7261 Counter Format

ORDER	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	SIGNIFICANCE
1	–	–	–	–	W	X	Y	Z	LSD
2	–	–	–	–	|	|	|	|	MSD
3	–	–	Hz	DP	|	|	|	|	2SD
4	–	–	s	|	|	|	|	|	3SD
5	–	–	ms	|	|	|	|	|	4SD
6	–	–	μs	|	|	|	|	|	5SD
7	–	–	kHz	|	|	|	|	|	6SD
8	–	–	MHz	DP	W	X	Y	Z	7SD

(2) 7220 Counter Format

ORDER	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	SIGNIFICANCE
1	–	–	–	–	W	X	Y	Z	LSD
2	–	–	–	–	|	|	|	|	MSD
3	–	–	–	–	|	|	|	|	2SD
4	–	–	Hz	DP	|	|	|	|	3SD
5	–	–	s	|	|	|	|	|	4SD
6	–	–	ms	|	|	|	|	|	5SD
7	–	–	μs	|	|	|	|	|	6SD
8	–	–	kHz	|	|	|	|	|	7SD
9	–	–	MHz	DP	W	X	Y	Z	8SD

(1) W, X, Y, Z represents a BCD value, with W = MSB, Z = LSB.
(2) DP, decimal point follows this digit when DP =1.

(3) 8600, 8800 Voltmeters

ORDER	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	SIGNIFICANCE
1	–	–	–	–	OVLD	a	b	c	Overload Range
2	–	–	–	–	W	X	Y	Z	3SD
3	–	–	–	–	POL	–	$\overline{\text{POL}}$	–	Polarity
4	–	–	–	–	Z	0	Z	$\overline{\text{Z}}$	MSD
5	–	–	–	–	W	X	Y	Z	2SD
6	–	–	–	–	W	X	Y	Z	5SD
7	–	–	–	–	W	X	Y	Z	LSD
8	–	–	–	–	W	X	Y	Z	4SD

(1) W, X, Y, Z represents a BCD value, with W = MSB, X = LSB.

Figure 604-3. Accepted BCD Data Formats

(4) 8920 Voltmeters

ORDER	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	SIGNIFICANCE
1	—	—	—	—	J′	L′	M′	N′	
2	—	—	—	—	K	a	b	c	
3	—	—	—	—	0	dB	OVLD	UNLD	
4	—	—	—	—	W	X	Y	Z	LSD
5	—	—	—	—	|	|	|	|	4SD
6	—	—	—	—	|	|	|	|	3SD
7	—	—	—	—	W	X	Y	Z	2SD
8	—	—	—	—	P—	1	0	Z	MSD

(1) W, X, Y, Z represents a BCD valued, with W = MSB, Z = LSB.
(2) dB = 1, instrument is in decibel mode.
(3) J′ = 1, instrument reading is 4 1/2 digits, when in linear mode.
(4) OVLD, reading is ⩾ max range.
(5) UNLD, reading is ⩽ 9% of range.
(6) a, b, c, — represents binary code range,
a = MSB, c = LSB
(7)

Connector Pin	Signal
9	DB0
10	DB1
11	DB2
12	DB3
13	DB4
14	DB5
15	DB6
16	DB7

Figure 604-3. Accepted BCD Data Formats (cont)

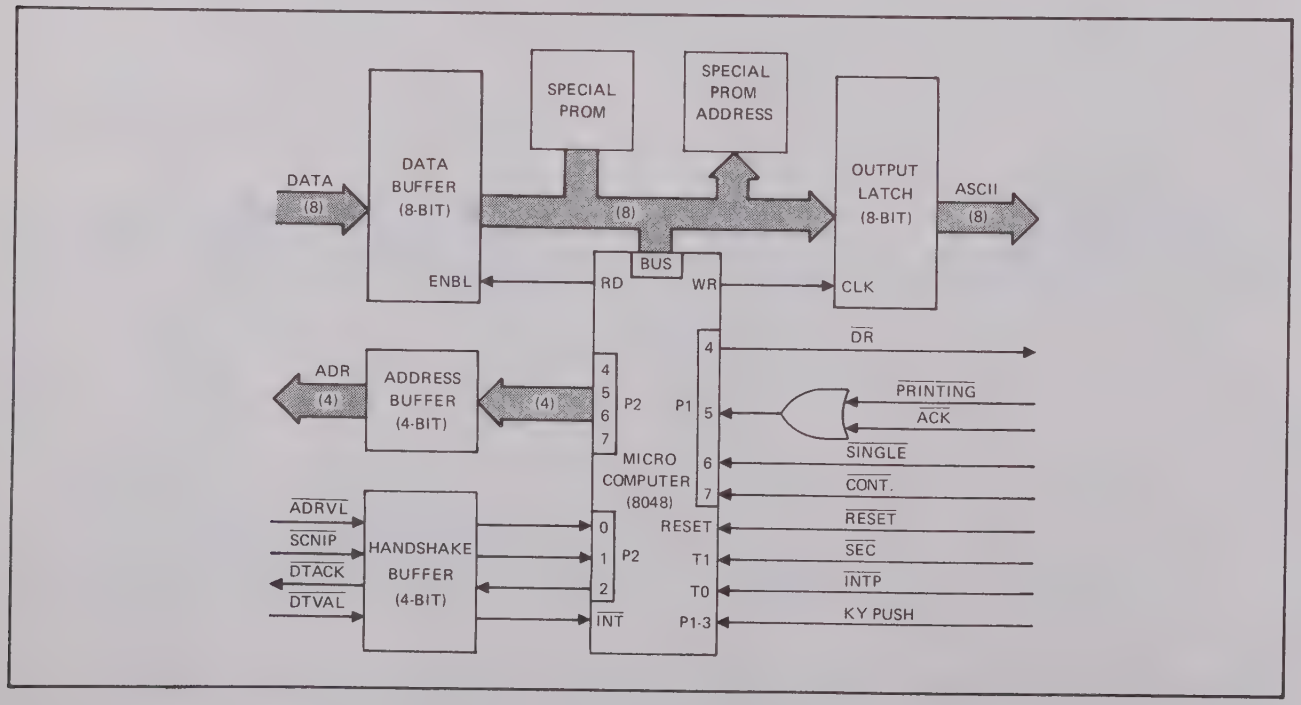


Figure 604-4. PTI Interface Block Diagram

604-23. Data is read into the 2020A microcomputer when the PTI Interface microcomputer sets the Data Ready (DR) line true. (Refer to Section 3 for 2020A handshake data transfer information.) When the Address Valid (ADRVL) goes true and data is read in, the microcomputer then sets all address lines high and tranforms the input data to ASCII, if required. If Scan In Progress (SCNIP) goes true after data is read in, and while ADRVL is still true, then the microcomputer does not update the address. Instead, it repeats the same address until such time as SCNIP goes false. A polling sequence ends when the address is incremented from 9 to 10, or when the continuous print signal goes false (high) if the printer was in the continuous print mode.

604-24. A special PROM, when installed, provides transform case tables in addition to those in the microcomputer ROM. The resident microcomputer program checks to see if the special PROM is installed. If it is, the transform case table in the special PROM is used in place of the microcomputer ROM transform case table.

604-25. MAINTENANCE

604-26. Refer to Section 4 of this manual for service information, cleaning instructions, and general maintenance instructions.

604-27. Performance Test

604-28. A partial PTI Interface performance test may be performed without connecting the printer to an input instrument. After power up, push the SINGLE PRINT switch; the paper should advance continuously until the SINGLE PRINT switch is released. Push the CONTINUOUS PRINT switch; the paper will advance one print line when the CONTINUOUS PRINT switch is released. The preceding steps verify that the microcomputer and output latch circuits are working. Further performance testing is performed with the PTI Interface installed in a known good 2020A Printer and connected to a known good input instrument. If the printer output matches the input instrument indication, the PTI Interface is operating properly.

604-29. Calibration Adjustments

604-30. The PTI Interface does not require periodic or post-repair calibration adjustment.

604-31. Troubleshooting

604-32. Troubleshooting information presented in Table 604-5 is intended as a guide to assist in malfunction isolation. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision is required, perform the next step in the table.

604-33. LIST OF REPLACEABLE PARTS

604-34. A list of replaceable parts for the PTI Interface is given in Table 604-6. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 604-5. PTI Interface Troubleshooting Guide

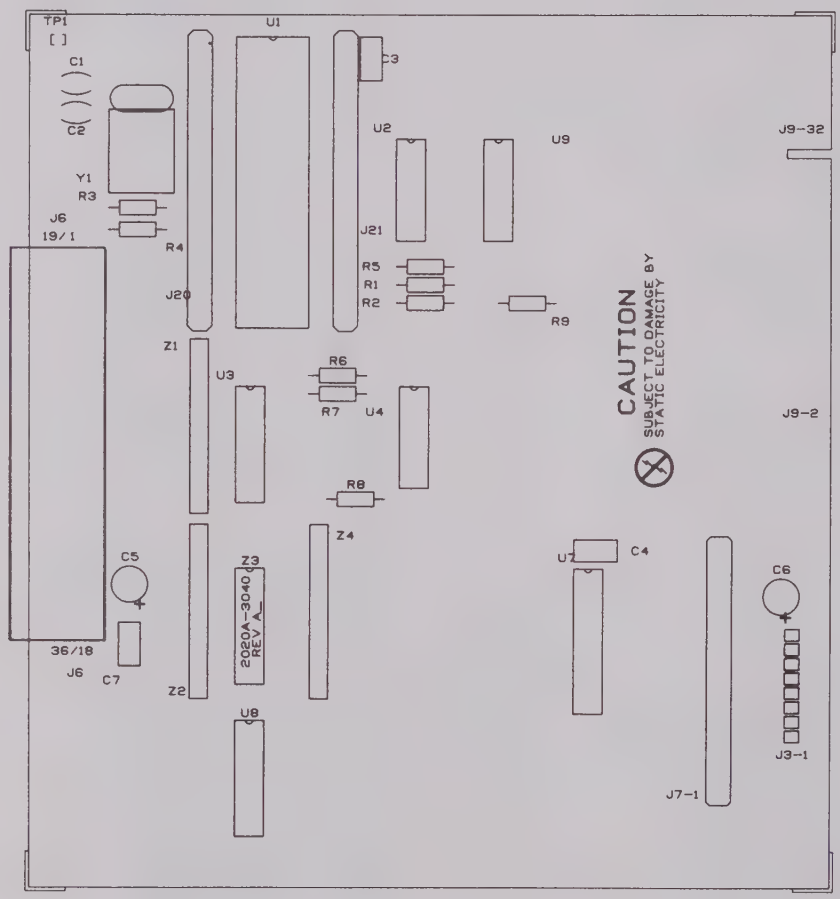
STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Does the printer paper advance when the Single Print switch is pushed?	5	2
2	Does Reset go low upon power up?	3	5
3	Is INT (I1, pin 6) high after power on reset?	6	4
4	Check DTVAL signal.		
5	Check RESET signal.		
6	Are handshake signals to and from Printer PCB working properly?	7	8
7	Check the output latch.		
8	Check the microcomputer.		

Table 604-.5 PTI Interface Troubleshooting Guide (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
9	Does the printer output match the information displayed on a known good input instrument?	18	10
10	Is a valid address present out of the address buffer?	12	11
11	Check the address buffer and microcomputer.		
12	Do the handshake signals function correctly?	14	13
13	Check the handshake buffer.		
14	Is data present at the data buffer output?	16	15
15	Check the data buffer.		
16	Is data present at the output buffer output?	18	17
17	Check the output buffer.		
18	Refer to 2020A Printer Troubelshooting Guide.		

Table 604-6. PTI Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	⊗PTI INTERFACE PCB ASSEMBLY FIGURE 604-5 (2020A-4040)	ORDER	BY	OPTION -004			
C1	CAP, CER, 20 PF +/-10%, 500V	106369	72982	831-000T2H0-200K	2		
C2	CAP, CER, 20 PF +/-10%, 500V	106369	72982	831-000T2H0-200K	REF		
C3	CAP, CER, 0.22 UF +/-%, 50V	309849	71590	CW30C224K	3		
C4	CAP, CER, 0.22 UF +/-%, 50V	309849	71590	CW30C224K	REF		
C5	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	2		
C6	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	REF		
C7	CAP, CER, 0.22 UF +/-%, 50V	309849	71590	CW30C224K	REF		
H1	SCREW, (MTG. TO J6, NOT SHOWN)	520106	89536	520106	2		
H2	SCREW, THRD/FORM (UNDER J6, NOT SHOWN)	448456	89536	448456	2		
H3	WASHER, SPLIT/LK #6 (TO J6, NOT SHOWN)	110692	73734	1358	2		
J3	CONNECTOR, RECEPTACLE, POST	267476	00779	85861-2	3		
J6	CONNECTOR, 36-PIN	493783	00779	552743-1	1		
J7	CONNECTOR, SOCKET, 18-PIN	435024	00779	583773-8	1		
J20	SOCKET, CONNECTOR, 20-PIN	443077	00779	583773-9	2		
J21	SOCKET, CONNECTOR, 20-PIN	443077	00779	583773-9	REF		
MP1	HOLDER, RUBBER COMPONENT	422857	98159	2829-75-1	1		
MP2	ADAPTER, CONNECTOR (TO J6, NOT SHOWN)	497313	89536	497313	1		
R1	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	3		
R2	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R3	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	1		
R4	RES, DEP. CAR, 1.2 +/-5%, 1/4W	442004	80031	CR251-4-5P1E2	1		
R5	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	4		
R7	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
U2⊗	IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	04713	MC14011CP	1	1	
U3⊗	IC, C-MOS, TRI-ST, HEX, NON INVRT BFFRS	407759	04713	MC14503CP	2	1	
U4⊗	IC, C-MOS, HEX, INVERTER	404681	04713	MC1406BCP	1	1	
U7	IC, LO-PWR SCHTKY, OCTAL "D" TYPE F/F	454892	01295	SN74LS273N	1	1	
U8⊗	IC, C-MOS, TRI-ST, HEX, NON INVRT BFFRS	407759	04713	MC14503CP	REF		
U9⊗	IC, C-MOS, DUAL TYPE "D", F/F	340117	04713	MC14013CP	1	1	
XU1	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		
Y1	CRYSTAL, 6 MHZ	461665	89536	461665	1		
Z1	RES, NETWORK, 100K	461038	89536	461038	2	1	
Z2	RES, NETWORK, 100K	461038	89536	461038	REF		
Z3	RES, NETWORK, 10K	500710	89536	500710	1	1	
Z4	RES, NETWORK, 10K	414003	89536	414003	1	1	



2020A-1640

Figure 604-5. PTI Interface PCB Assembly

Option -005
Parallel BCD Interface

605-1. INTRODUCTION

605-2. Input Option -005 is a Parallel BCD Interface for the Model 2020A. It contains a logic network capable of accepting eleven 4-bit BCD words in a character-parallel format and converting the input BCD characters to equivalent ASCII characters for input to the 2020A microcomputer. The first seven 4-bit BCD words are data input; the last four BCD words are annotation input. Data transfer from the Parallel BCD Interface to the 2020A circuitry is accomplished using the handshake mode.

605-3. Parallel BCD Interface installation is possible in the field as well as at the factory. It is compatible with Option -006, the Interval Timer and it is plug compatible with accessory Y2028, the Interface (BCD to PTI). The standard character set is shown in Table 605-1. Standard input connector pin usage is given in Table 605-2.

605-4. A decimal point is switch selectable to any point in the eleven column BCD field. A decimal code 14 on any of the seven data inputs will produce a fixed decimal point in that column. The decimal point may also be assigned to any position through a 4-bit BCD input. This remotely assigned decimal point position is a jumper selectable feature. One column of annotation data must be sacrificed to allow remote decimal point control.

605-5. SPECIFICATIONS

605-6. The Parallel BCD Interface meets all temperature, humidity, vibration, and power specifications listed for the 2020A Printer. Additional specifications applicable to the Parallel BCD Interface are listed in Table 605-3.

Table 605-1. Parallel BCD Character Set

BINARY CODE	HEX CODE	BCD	ANNOTATION			
		Col. 10-16	Col. 17	Col. 18	Col. 19	Col. 20
1111	F	Space	Space	Space	Space	Space
1110	E	.	m (milli)	A	D	C
1101	D	>	μ (micro)	V	A	G
1100	C	<	n (nano)	s	L	B
1011	B	+	p (pico)	Ω	J	A
1010	A	–	f (femto)	S	K	Q
1001	9	9	k (kilo)	W	H	R
1000	8	8	M	H	z	U
0111	7	7	G	F	S	V
0110	6	6	K	/	s	W
0101	5	5	P	P	M	X
0100	4	4	I	N	*	Y
0011	3	3	F	T	O	Z
0010	2	2	R	M	P	E
0001	1	1	%	#	I	N
0000	0	0	° (degree)	C	F	T

Table 605-.2 Input Connector Pin Usage

CHARACTER	BIT 1	BIT 2	BIT 4	BIT 8
1	22	47	23	48
2	20	45	21	46
3	18	43	19	44
4	16	41	17	42
5	14	39	15	40
6	12	37	13	38
7	10	35	11	36
8	8	33	9	34
9	6	31	7	32
10	4	29	5	30
11*	2	27	3	28

* OR decimal point if 10k resistor network is in Z25 position.

Table 605-3. Parallel BCD Interface Specifications

Connectors	Qty. 1 — 50-pin male
Input Signals	11 Data Words, 4-bit BCD DOU Busy Line - indicates Data Ready for Input.
Output Signals	Two trigger outputs, one positive-true logic; one negative-true logic.
Scan Capability	None
Character Set	See Table 605-1.
Decimal Point	Jumper selection of either: A. Fixed Decimal Point (position is switch selectable). B. Remotely BCD Programmable Decimal Point.
Standard Column Usage	Jumper selection of either: A. 7 data +4 annotation. B. 7 data +3 annotation with BCD Programmable decimal point.
Buffer Storage	One Line.

605-7. INSTALLATION

NOTE

Verify that the DOU BUSY jumper is installed correctly for desired method of operation before installing the BCD Interface. Refer to Operating Notes.

605-8. To install or exchange input interface options, use the following procedure:

1. Disconnect all 2020A power cords and input connections.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear of the unit by pulling straight up.

NOTE

Steps a and b are necessary only if the 2020A Printer is equipped with Interval Timer Option -006.

a. Remove the two screws holding the Interval PCB to the interface pcb then pull the rear edge of the Interval PCB up to disconnect it from the interface pcb.

b. Pull the Interval PCB toward the rear of the 2020A Printer to disconnect it from the Keyboard PCB.

4. Remove the single screw at the front of the interface pcb and the two screws securing the connector to the 2020A Printer rear panel.

5. Disconnect the ribbon cable between the interface pcb and the 2020A Printer PCB, then remove the interface pcb.

6. To reinstall the interface pcb, first reconnect the ribbon cable between the interface pcb and the 2020A Printer PCB.

7. Position the interface pcb and install the three retaining screws. (One at the front and two securing the connector to the 2020A rear panel.)

8. Reinstall the Interval PCB if necessary.

9. Replace the 2020A Printer case cover.

10. Replace the four cover retaining screws in the bottom of the 2020A case.

605-9. OPERATING NOTES

605-10. Decimal Point

605-11. Decimal point position is selectable through switch S1. Prior to operation, verify that switch S1 is set to the hex code for the BCD column before which the decimal point is to appear. See Table 605-4.

Table 605-4. Switch S1, Decimal Point Position Selection

SWITCH S1				DECIMAL POINT POSITION										
4	3	2	1	1	2	3	4	5	6	7	8	9	10	11
ON	ON	ON	ON	. X	X	X	X	X	X	X	X	X	X	X
ON	ON	ON	OFF	.X	X	X	X	X	X	X	X	X	X	X
ON	ON	OFF	ON	X .	X	X	X	X	X	X	X	X	X	X
ON	ON	OFF	OFF	X	X .	X	X	X	X	X	X	X	X	X
ON	OFF	ON	ON	X	X	X .	X	X	X	X	X	X	X	X
ON	OFF	ON	OFF	X	X	X	X .	X	X	X	X	X	X	X
ON	OFF	OFF	ON	X	X	X	X	X .	X	X	X	X	X	X
ON	OFF	OFF	OFF	X	X	X	X	X	X .	X	X	X	X	X
OFF	ON	ON	ON	X	X	X	X	X	X	X .	X	X	X	X
OFF	ON	ON	OFF	X	X	X	X	X	X	X	X .	X	X	X
OFF	ON	OFF	ON	X	X	X	X	X	X	X	X	X .	X	X
OFF	ON	OFF	OFF	X	X	X	X	X	X	X	X	X	X .	X
OFF	OFF	ON	ON	X	X	X	X	X	X	X	X	X	X	X .
OFF	OFF	ON	OFF	X	X	X	X	X	X	X	X	X	X	X
Additional Switch Codes result in No Decimal Point Print														

605-12. Decimal point position may also be established by a 4-bit code through connector J6, pins 28, 3, 27, and 2. However, a minor modification to the Parallel BCD Interface PCB is necessary. Remove the 10k resistor network from pcb location Z22 and place it in location Z25. No soldering is necessary; the resistor network is socket mounted. All segments of switch S1 must be placed in the OFF position. Decimal point position may now be programmed through the last input position. Consequently, the last annotation character is sacrificed; the last annotation character will print blank.

605-13. Decimal point position programming through connector J6 is similar to decimal point position selection using switch S1. Pin 2 of J6 is equivalent to segment 1 of switch S1; pin 27 is equivalent to segment 2; pin 3 is equivalent to segment 3; and pin 28 is equivalent to switch segment 4. A low logic level at a pin of J6 is equivalent to the ON condition of a switch segment; a high logic level is equivalent to an OFF switch condition. See Table 605-5.

605-14. Busy Signal Jumper

605-15. Jumper selection of either positive-true or negative-true DOU BUSY signal operation is possible. Prior to operating the 2020A Printer with the Parallel BCD Interface, check the DOU BUSY signal jumper to make sure it conforms to input instrument logic sense. For operation with input instruments using DOU BUSY positive-true, jumper connection between E1 and E2 must exist; for operation with input instruments using DOU BUSY negative-true, jumper connection between E2 and E3 must exist.

605-16. OPERATING INSTRUCTIONS

605-17. Model 2020A Printer operating instructions are valid for printers with the Parallel BCD Interface installed. After verifying correct decimal point selection through switch S1, and proper DOU BUSY signal jumpering, operate the 2020A Printer is directed in Section 2. If the Interval Timer is also installed, refer to the Interval Timer Option -006, operating instructions.

605-18. THEORY OF OPERATION

605-19. Overall Functional Description

605-20. The Parallel BCD Interface converts character-parallel BCD input data to character-serial ASCII data for input to the 2020A Printer microcomputer. BCD input data is received in eleven 4-bit latches, then shifted out, one character at a time, into a PROM. The PROM performs a BCD to ASCII conversion, then the ASCII data is handshake tranferred into the 2020A microcomputer. Through counter/decoder and decimal point decode circuitry, a decimal point may be inserted between any two characters in the character string.

605-21. A four state interface control circuit provides control signals which load input data into the latch circuit, and handshake control, to transfer ASCII output data to the 2020A microcomputer. The interface control circuit also supplies both positive and negative trigger pulses for use by the instrument supplying input data.

Table 605-5. BCD Code, Decimal Point Position Selection

BCD CODE AT CONNECTOR PINS (J6)				DECIMAL POINT POSITION										
28	3	27	2	1	2	3	4	5	6	7	8	9	10	11
0	0	0	0	. X	X	X	X	X	X	X	X	X	X	X
0	0	0	1	.X	X	X	X	X	X	X	X	X	X	X
0	0	1	0	X	.X	X	X	X	X	X	X	X	X	X
0	0	1	1	X	X	.X	X	X	X	X	X	X	X	X
0	1	0	0	X	X	X	.X	X	X	X	X	X	X	X
0	1	0	1	X	X	X	X	.X	X	X	X	X	X	X
0	1	1	0	X	X	X	X	X	.X	X	X	X	X	X
0	1	1	1	X	X	X	X	X	X	.X	X	X	X	X
1	0	0	0	X	X	X	X	X	X	X	.X	X	X	X
1	0	0	1	X	X	X	X	X	X	X	X	.X	X	X
1	0	1	0	X	X	X	X	X	X	X	X	X	.X	X
1	0	1	1	X	X	X	X	X	X	X	X	X	X	X
1	1	0	0	X	X	X	X	X	X	X	X	X	X	X.
1	1	0	1	X	X	X	X	X	X	X	X	X	X	X

Additional BCD codes result in no decimal point.

605-22. Block Diagram Analysis

605-23. Refer to Figure 605-1, the Parallel BCD Interface Block Diagram. All interface functions and data transfers are controlled by the interface control circuitry. The interface control circuit is a four state machine, with each state or condition initiated by various signals, and with different circuit functions initiated by the different states. Refer to Figure 605-2, Interface Control Circuit State Diagram.

605-24. Interface control circuit states are dependent on the outputs of a dual D type flip-flop in the interface control circuitry. Table 605-6 lists the states, flip-flop outputs, and state names.

605-25. When power is applied to the 2020A Printer circuitry, the RESET signal goes true. RESET true initiates a State 1 condition, the Reset or Idle State, by supplying a reset input to flip-flop A and flip-flop B through a NOR gate. Neither flip-flop can respond to any other input while RESET is true. As soon as RESET goes false, both state elements can respond if other inputs are present.

605-26. After RESET goes false, the interface control circuit remains in State 1 until a PRINT command is generated. The PRINT command is supplied through a gate when the SINGLE, CONT, or INTP signal goes true. Upon receipt of a PRINT command, the interface control elements make a transition to State 2, the Trigger State, only if DOU BUSY is false. The DOU BUSY signal is false if the input instrument is not, at present, shifting data into its outputs.

605-27. With DOU BUSY false, the interface control circuit enters State 2. When the State 1 to State 2 transition occurs, flip-flop element "B" is set with its Ω output true (see Table 605-4). The true "B" output produces a TRIGGER pulse from U16B and triggers a time out delay of 11 seconds (T2), produced by U19A. If the input instrument does not respond by setting DOU BUSY true within 11 seconds, then U19B generates a 2 μs pulse which resets flip-flop element "B" to the State 1 condition. If the PRINT command remains true after the 2 μs delay, the State 1 to State 2 transition recurs, producing a new TRIGGER pulse.

605-28. If the instrument supplying input signals responds to the TRIGGER pulse by sending DOU BUSY true within the 11 second (T2) delay period, then a transition from State 2 to State 3 takes place. The DOU BUSY signal true indicates that the input instrument has started transferring data into its output. When all data has been transferred into the output latches, DOU BUSY again goes false. This triggers the data load delay (U16A) which, after approximately 500 μs (T1), resets flip-flop element "B" to initiate a State 4 condition (see Table 605-4).

605-29. In State 4, the load and transfer state, the LOAD signal goes true as a result of flip-flop element "A"

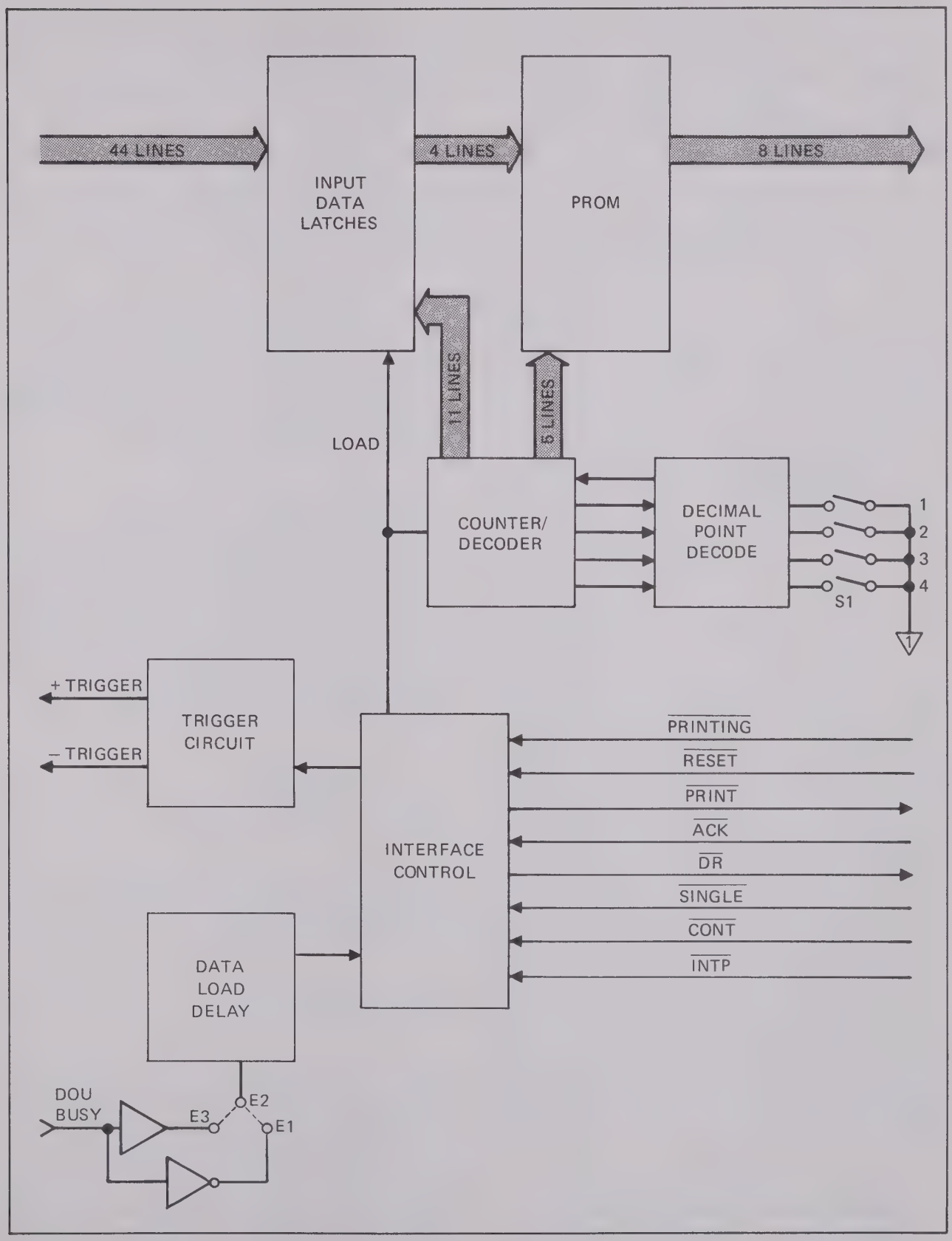


Figure 605-1. Parallel BCD Input Interface Block Diagram

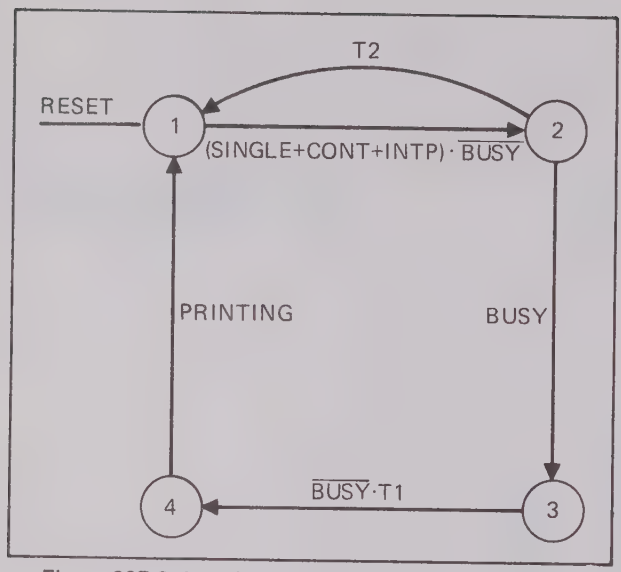


Figure 605-2. Interface Control Circuit State Diagram

Table 605-6. Interface Control Circuit States

STATE	FLIP-FLOP		DESCRIPTION
	A	B	
1	0	0	Reset, or Idle State
2	0	1	Trigger State
3	1	1	Wait for Valid Data State
4	1	0	Load and Transfer State

being true while "B" is false. The LOAD signal latches input data into the 11 input latch circuits. Data Ready (DR) goes true as a result, and the PROM sends an ASCII "Space" code to the 2020A microcomputer to initiate the handshake data transfer. When the microcomputer returns Acknowledge (ACK) true, DR goes false and the counter in the counter/decoder circuit advances. Through the 4-to-16 line decoder in the counter/decoder circuit, the counter output condition selects the first latch. Data from that latch addresses the PROM and is converted from a 4-bit BCD character to the equivalent 8-bit ASCII character for transfer to the 2020A microcomputer. When the microcomputer sends ACK false, the DR goes true after a short delay caused by gating. The microcomputer accepts the character and sends ACK true again, resulting in DR going false. As DR goes false the counter advances and the next latch is selected through the decoder. Data from that latch is then tranformed to ASCII and transferred in the same manner. This sequence is repeated for each of the 11 character latches.

NOTE

The last four characters are annotation. The decoder outputs to the last four latches also address different PROM blocks for these characters.

605-30. When the 11th character has been sent and acknowledged, the counter advances to a count of 12 and, through the decoder, addresses a PROM block containing an ASCII Line Feed code. When the 2020A microcomputer receives the Line Feed code, it starts printing the information, and it sets the PRINTING line true. PRINTING true resets flip-flop element "A" and returns the interface control logic to State 1. In State 1 the LOAD line goes false, resetting the counter to zero and disabling the DR signal to prevent further handshake cycles.

605-31. When the interface control logic is in State 4, the load and transfer state, a decimal point may be inserted in the character string in any position. The binary equivalent of decimal point location is established through switch S1. Refer to Table 605-5. The binary switch code is set equal to the character number that will appear to the right of the decimal point.

605-32. When the count from the counter/decoder equals the binary code selected, the decimal point decode circuit output goes high. With decimal point decode high, the counter/decoder circuit is disabled, forcing the PROM to address the decimal point. With the counter disabled, the DR signal going false after transfer will not advance the counter. Therefore, when the decimal point decode output returns low, the counter circuit will resume operating and transfer the next character without skipping a character.

605-33. MAINTENANCE

605-34. Refer to Section 4 of this manual for service information, cleaning instructions, and general maintenance instructions.

605-35. Performance Test

605-36. A performance test of Parallel BCD Interface circuits may best be performed under actual operating conditions. Install the Parallel BCD Interface in a known good 2020A Printer. Connect a known good instrument to the input connector. Select the desired decimal point position and DOU BUSY signal logic sense. If the printer output matches the information displayed on the input instrument, the Parallel BCD Interface is operating correctly.

605-37. Calibration Adjustment

605-38. Parallel BCD Interface does not require periodic or post-repair calibration adjustment.

605-39. Troubleshooting

605-40. Troubleshooting information presented in Table 605-7 is intended as a guide to assist in malfunction isolation. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision is required, perform the next step in the table.

605-42. LIST OF REPLACEABLE PARTS

605-43. A list of replaceable parts for the Parallel BCD Interface is given in Table 605-8. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 605-7. Parallel BCD Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do "A" and "B" flip-flop elements (U23) cycle through all states?	3	2
2	Check handshake and BUSY signal circuitry.		
3	Is a LOAD signal present at the counter (U10) and all Input Data Latches?	5	4
4	Check the interface control gates (U22, U25).		
5	Are decoder circuit outputs present at the Input Data Latches?	7	6
6	Check the counter (U10) and decoder (U7).		
7	Does data transfer from the Input Data Latches to the PROM?	9	8
8	Check the latch circuits.		
9	Is data present at the PROM outputs?	11	10
10	Check the PROM.		
11	Is the decimal point inserted in the character string at the proper place?	13	12
12	Check decimal point decode circuitry (U5, U11, U13).		
13	Parallel BCD Input Interface Assembly troubleshooting is complete. Disconnect all test equipment.		

Table 605-8. Parallel BCD Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	⊗PARALLEL BCD INTERFACE PCB ASSEMBLY FIGURE 605-3 (2020A-4050)	ORDER	BY	OPTION -005			
C1	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	2		
C3	CAP, CER, 2700 PF +/-20%, 100V	362889	80031	2222-630-01-272	1		
C4	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C5	CAP, CER, 100PF +/-2%, 100V	362665	72982	8131-A100-T2H-101G	1		
C6	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	REF		
C7	CAP, CER, 0.025 UF +/-20%, 25V	168435	56289	C023B101H253M	2		
C8	CAP, CER, 0.025 UF +/-20%, 25V	168435	56289	C023B101H253M	REF		
E1	JUMPER STRIP	373316	89536	373316	3		
E2	JUMPER STRIP	373316	89536	373316	REF		
E3	JUMPER STRIP	373316	89536	373316	REF		
H1	SCREW, THRD/FORM (UNDER J6, NOT SHOWN)	448456	89536	448456	2		
H2	SCREW, CONNECTOR J6 MTG (NOT SHOWN)	520106	00779	552657-1	2		
H3	WASHER, SPLIT/LK #6 (TO J6, NOT SHOWN)	110692	73734	1358	2		
J3	CONNECTOR, BD MNT, RECEPTACLE	267476	00779	85861-2	8		
J6	CONNECTOR, PLUG	493791	00779	552726-1	1		
J7	CONNECTOR, SOCKET, 18-PIN	435024	00779	583773-8	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	4		
R2	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R3	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R4	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	4		
R5	RES, DEP. CAR, 110K +/-5%, 1/4W	442426	80031	CR251-4-5P110K	1		
R6	RES, DEP. CAR, 750K +/-5%, 1/4W	442525	80031	CR251-4-5P750K	1		
R7	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	1		
R10	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R12	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
S1	SWITCH, SPST, DIP	495218	00779	435802-3	1		
U2⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	11	3	
U3⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U5⊗	IC, C-MOS, DUAL, 4-INPUT, NOR GATES	363820	12040	MM5602AN	1	1	
U6⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U7⊗	IC, C-MOS, 4-BIT LATCH, LINE DECODER	355156	04713	MC14515BCP	1	1	
U9⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U10⊗	IC, C-MOS, DUAL, UP COUNTER	355164	04713	MC14520BCP	1	1	
U11⊗	IC, C-MOS, QUAD, EXCLUSIVE OR GATE	355222	02735	CD4030AE	1	1	
U12⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U13	IC, DUAL TYPE D F/F	340117	04713	MC14013CP	2	1	
U14⊗	IC, C-MOS, HEX INVERTER	404681	04713	MC1406BCP	1	1	
U15⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U16⊗	IC, C-MOS, RETRIG. MONO/MULTIVIBRATOR	393512	04713	MC14528CP	2	1	
U18⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U19⊗	IC, C-MOS, RETRIG. MONO/MULTIVIBRATOR	393512	04713	MC14528CP	REF		
U21⊗	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U22⊗	IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	04713	MC14011CP	1	1	

Table 605-8. Parallel BCD Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U23	IC, DUAL TYPE D F/F	355164	04713	MC14520BCP	REF		
U24Ø	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U25Ø	IC, C-MOS, TRIPLE 3-INPUT AND GATE	408807	04713	MC14073CP	1	1	
U26Ø	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U27Ø	IC, C-MOS, QUAD, CLKD D-LATCH, TRI-STATE	412742	12040	MM74C173N	REF		
U28Ø	IC, C-MOS, HEX, BUFFER/INVERTERS	381843	04713	MC14049CP	1	1	
XU4	IC, SOCKET, 20-PIN	454421	09922	DILB20P-108	1		
XZ22/Z25	SOCKET, RESISTOR NETWORK, 16-PIN	370312	91506	316-AG39D	1		
Z1	RES, NETWORK, 10K	513309	89536	513309	11		
Z2	RES, NETWORK, 100K	412726	89536	412726	11		
Z3	RES, NETWORK, 10K	513309	89536	513309	REF		
Z4	RES, NETWORK, 100K	412726	89536	412726	REF		
Z5	RES, NETWORK, 10K	513309	89536	513309	REF		
Z6	RES, NETWORK, 100K	412726	89536	412726	REF		
Z7	RES, NETWORK, 10K	513309	89536	513309	REF		
Z8	RES, NETWORK, 100K	412726	89536	412726	REF		
Z9	RES, NETWORK, 10K	513309	89536	513309	REF		
Z10	RES, NETWORK, 100K	412726	89536	412726	REF		
Z11	RES, NETWORK, 10K	513309	89536	513309	REF		
Z12	RES, NETWORK, 100K	412726	89536	412726	REF		
Z13	RES, NETWORK, 100K	412726	89536	412726	REF		
Z14	RES, NETWORK, 10K	513309	89536	513309	REF		
Z15	RES, NETWORK, 100K	412726	89536	412726	REF		
Z16	RES, NETWORK, 10K	513309	89536	513309	REF		
Z17	RES, NETWORK, 100K	412726	89536	412726	REF		
Z18	RES, NETWORK, 10K	513309	89536	513309	REF		
Z19	RES, NETWORK, 100K	412726	89536	412726	REF		
Z20	RES, NETWORK, 10K	513309	89536	513309	REF		
Z21	RES, NETWORK, 100K	412726	89536	412726	REF		
Z22	RES, NETWORK, 10K	513309	89536	513309	REF		
Z23	RES, NETWORK, 470K	519306	89536	519306	2		
Z24	RES, NETWORK, 10K	355305	89536	355305	1		
Z26	RES, NETWORK, 470K	519306	89536	519306	REF		

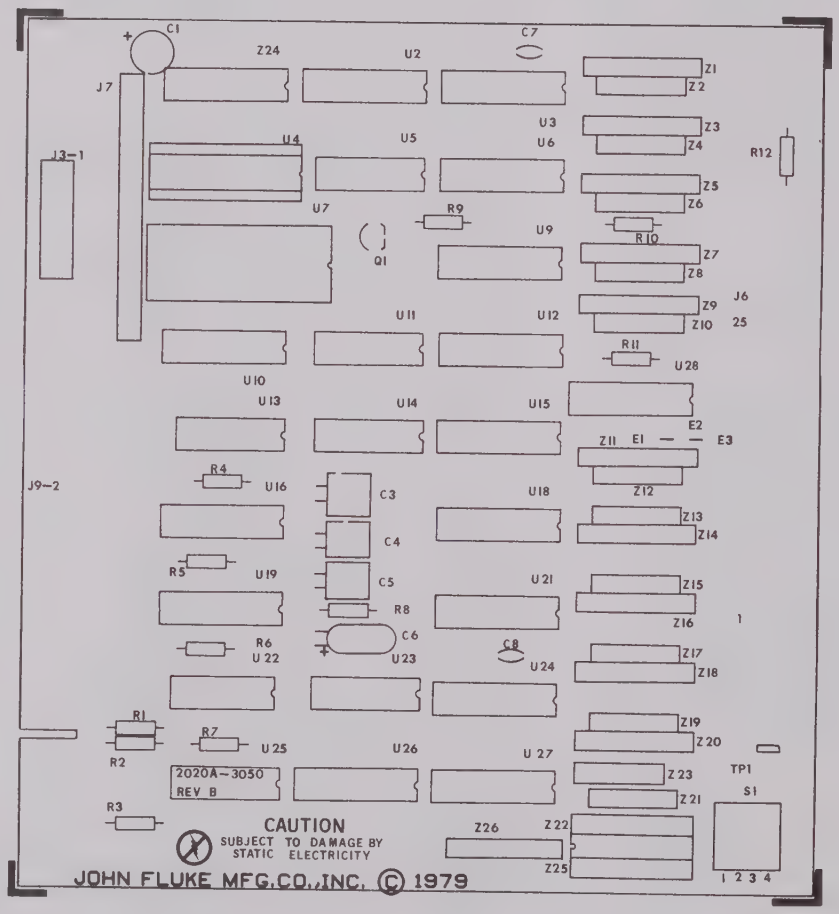


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Figure 605-3. Parallel BCD Interface PCB Assembly

Option -006
Interval Timer

606-1. INTRODUCTION

606-2. Option -006, the Interval Timer, provides selection of fixed interval data printouts. Four time intervals are selectable, and each interval may be multipled by two, four, or eight. Only one time interval and one multiplier may be selected concurrently. The 16 possible print intervals are listed in Table 606-1.

Table 606-1. Print Intervals

TIME INTERVAL	MULTIPLIER			
	X1	X2	X4	X8
10 SEC	10 SEC	20 SEC	40 SEC	80 SEC
1 MIN	1 MIN	2 MIN	4 MIN	8 MIN
10 MIN	10 MIN	20 MIN	40 MIN	80 MIN
1 HOUR	1 HOUR	2 HOUR	4 HOUR	8 HOUR

606-3. The Interval Timer is field installable or factory installable. It is compatible with all five input interface options. When Interval Print mode is in use, the Interval Timer will print the elapsed time, counting from the last reset, prior to each print scan.

606-4. Physically, the Interval Timer Option consists of two units: the Interval PCB and the Keyboard Assembly. All operator input is through the Keyboard, which contains four time interval switches and four multiplier switches. The different switch connections made through the Keyboard control timer circuitry on the Interval PCB to produce the various print intervals.

606-5. SPECIFICATIONS

606-6. The Interval Timer meets all temperature, humidity, vibration, and power specifications listed for the 2020A Printer. Additional specifications applicable to the Interval Timer are listed in Table 606-2.

Table 606-2. Interval Print Assembly Specifications

Installation	Field or factory
Selectable Print Intervals	16, from 1 sec to 8 hours (see Table 606-1).
Elapsed Time	Prints elapsed time at start of each print.
Signal Lines	
RESET	Terminate Interval print mode and Resets elapsed time to 0.
CLEAR	w/-004 Option, Reset 2020A elapsed time clock.
SEC	Increments 2020A elapsed time clock.
PRINTING	2020A printing.
INTP	Initiates 2020A PRINT.

606-7. INSTALLATION

606-8. To install the Interval Timer, use the following procedure:

1. Disconnect the 2020A power and signal cables.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear of the unit by pulling straight up.

4. Remove the two connector retaining screws at the rear of the interface pcb.

5. Remove the front interface pcb retaining screw, and the two Printer PCB retaining screws: one at

the front in the center and one near the middle of the Printer PCB.

6. Tilt the front of the Printer PCB up slightly, and remove the 2020A case front panel.

7. Clip the Keyboard into the new front panel supplied with the Interval Timer.

8. Tilt the front of the Printer PCB up and install the new front panel over the Printer PCB switches.

9. Reinstall the Printer PCB and rear panel connector retaining screws.

10. Position the Interval board female connections on the Keyboard male connection pins and install.

11. Push the Interval board male connection pins into the female connections provided on the interface pcb.

12. Install the two screws necessary to secure the interface pcb and the Interval PCB.

606-9. OPERATING INSTRUCTIONS

606-10. With the Interval Timer installed, SINGLE PRINT, CONTINUOUS PRINT, PAPER ADVANCE, and POWER switch operating instructions remain as described in Section 2 of this manual. Interval Timer operating instructions are detailed in the following procedure.

1. Push the 2020A POWER ON switch.

2. To initiate the self-test function, push PAPER ADVANCE within one second of POWER ON.

3. Push the switch for the desired print interval. If necessary, select a multiplier to establish the desired interval.

NOTE

Only one interval (10 second, 1 minute, 10 minute, or 1 hour) and one multiplier (X2, X4, or X8) may be selected simultaneously.

4. To change the print interval, select a different interval or a different multiplier or both.

5. The new interval print time selected will start from the last previous print, not from the time a switch is selected. Example: assume the printer has been operating with a print interval of 2 minutes. One minute after a print cycle, the interval is changed to 4 minutes by pushing the X4 multiplier. The next print cycle will start 3 minutes from the time the X4 multiplier switch was pushed, 4 minutes from the last print cycle.

6. To terminate interval print mode operation, push the RESET key. (RESET does not terminate SINGLE or CONT print modes.)

606-11. THEORY OF OPERATION

606-12. Functional Description

606-13. Interval Timer circuitry provides a print command (INTP) to the 2020A microcomputer at precisely controlled, selectable time intervals. A crystal controlled time base circuit provides four basic time pulses. Operator selected keys, through a key select and a flip-flop circuit, select one of the four time pulses for input to a divider. The divider, in turn, supplies the basic time interval pulse, and three multiples (X2, X4, X8) of that pulse, to a second switch circuit. Keyboard multiplier inputs, through the key select circuit and a flip-flop, determine which of the four inputs the switch circuit selects. Either the base time interval or one of the multiples of that interval is routed through a one-shot circuit and a flip-flop to provide a print command to the 2020A microcomputer. Refer to Figure 606-1.

606-14. Outputs from the key select circuit also control front panel LEDs to indicate the time interval and multiplier selected. Refer to Figure 606-2. The two LED control circuits select one of the lines (X1, X2, X3, X4) from the key select circuit. The selected output supplies voltage to the keyboard LEDs. Ground is supplied through the proper switch to light the proper LED. The LED control circuits are the "B" halves of switches 1A and 2A in the time interval circuit, therefore, they share control inputs with switch 1A and 2A shown in Figure 606-1.

606-15. Block Diagram Analysis

606-16. Refer to Figure 606-1. The time base circuitry provides four basic times, but all selection and control stems from the key select circuit. The key select circuit includes a 16-key encoder, a buffer inverter and a gate circuit. Active low signals generated within the 16-key encoder are outputs at X1, X2, X3, and X4. These outputs are routed to the Keyboard through P10-J10. Refer to the keyboard schematic, Figure 606-3. For discussion purposes, assume that the 10 second key and the X2 key have been pushed to produce a 20 second print interval. Key Encoder output X1 is supplied, through two switches, to both the Y2 and Y3 inputs of the key encoder.

Option -006
Interval Timer

606-1. INTRODUCTION

606-2. Option -006, the Interval Timer, provides selection of fixed interval data printouts. Four time intervals are selectable, and each interval may be multipled by two, four, or eight. Only one time interval and one multiplier may be selected concurrently. The 16 possible print intervals are listed in Table 606-1.

Table 606-1. Print Intervals

TIME INTERVAL	MULTIPLIER			
	X1	X2	X4	X8
10 SEC	10 SEC	20 SEC	40 SEC	80 SEC
1 MIN	1 MIN	2 MIN	4 MIN	8 MIN
10 MIN	10 MIN	20 MIN	40 MIN	80 MIN
1 HOUR	1 HOUR	2 HOUR	4 HOUR	8 HOUR

606-3. The Interval Timer is field installable or factory installable. It is compatible with all five input interface options. When Interval Print mode is in use, the Interval Timer will print the elapsed time, counting from the last reset, prior to each print scan.

606-4. Physically, the Interval Timer Option consists of two units: the Interval PCB and the Keyboard Assembly. All operator input is through the Keyboard, which contains four time interval switches and four multiplier switches. The different switch connections made through the Keyboard control timer circuitry on the Interval PCB to produce the various print intervals.

606-5. SPECIFICATIONS

606-6. The Interval Timer meets all temperature, humidity, vibration, and power specifications listed for the 2020A Printer. Additional specifications applicable to the Interval Timer are listed in Table 606-2.

Table 606-2. Interval Print Assembly Specifications

Installation	Field or factory
Selectable Print Intervals	16, from 1 sec to 8 hours (see Table 606-1).
Elapsed Time	Prints elapsed time at start of each print.
Signal Lines	
RESET	Terminate Interval print mode and Resets elapsed time to 0.
CLEAR	w/-004 Option, Reset 2020A elapsed time clock.
SEC	Increments 2020A elapsed time clock.
PRINTING	2020A printing.
INTP	Initiates 2020A PRINT.

606-7. INSTALLATION

606-8. To install the Interval Timer, use the following procedure:

1. Disconnect the 2020A power and signal cables.

2. Remove the four cover retaining screws in the bottom of the 2020A Printer case.

3. Lift the cover clear of the unit by pulling straight up.

4. Remove the two connector retaining screws at the rear of the interface pcb.

5. Remove the front interface pcb retaining screw, and the two Printer PCB retaining screws: one at

the front in the center and one near the middle of the Printer PCB.

6. Tilt the front of the Printer PCB up slightly, and remove the 2020A case front panel.

7. Clip the Keyboard into the new front panel supplied with the Interval Timer.

8. Tilt the front of the Printer PCB up and install the new front panel over the Printer PCB switches.

9. Reinstall the Printer PCB and rear panel connector retaining screws.

10. Position the Interval board female connections on the Keyboard male connection pins and install.

11. Push the Interval board male connection pins into the female connections provided on the interface pcb.

12. Install the two screws necessary to secure the interface pcb and the Interval PCB.

606-9. OPERATING INSTRUCTIONS

606-10. With the Interval Timer installed, SINGLE PRINT, CONTINUOUS PRINT, PAPER ADVANCE, and POWER switch operating instructions remain as described in Section 2 of this manual. Interval Timer operating instructions are detailed in the following procedure.

1. Push the 2020A POWER ON switch.

2. To initiate the self-test function, push PAPER ADVANCE within one second of POWER ON.

3. Push the switch for the desired print interval. If necessary, select a multiplier to establish the desired interval.

NOTE

Only one interval (10 second, 1 minute, 10 minute, or 1 hour) and one multiplier (X2, X4, or X8) may be selected simultaneously.

4. To change the print interval, select a different interval or a different multiplier or both.

5. The new interval print time selected will start from the last previous print, not from the time a switch is selected. Example: assume the printer has been operating with a print interval of 2 minutes. One minute after a print cycle, the interval is changed to 4 minutes by pushing the X4 multiplier. The next print cycle will start 3 minutes from the time the X4 multiplier switch was pushed, 4 minutes from the last print cycle.

6. To terminate interval print mode operation, push the RESET key. (RESET does not terminate SINGLE or CONT print modes.)

606-11. THEORY OF OPERATION

606-12. Functional Description

606-13. Interval Timer circuitry provides a print command (INTP) to the 2020A microcomputer at precisely controlled, selectable time intervals. A crystal controlled time base circuit provides four basic time pulses. Operator selected keys, through a key select and a flip-flop circuit, select one of the four time pulses for input to a divider. The divider, in turn, supplies the basic time interval pulse, and three multiples (X2, X4, X8) of that pulse, to a second switch circuit. Keyboard multiplier inputs, through the key select circuit and a flip-flop, determine which of the four inputs the switch circuit selects. Either the base time interval or one of the multiples of that interval is routed through a one-shot circuit and a flip-flop to provide a print command to the 2020A microcomputer. Refer to Figure 606-1.

606-14. Outputs from the key select circuit also control front panel LEDs to indicate the time interval and multiplier selected. Refer to Figure 606-2. The two LED control circuits select one of the lines (X1, X2, X3, X4) from the key select circuit. The selected output supplies voltage to the keyboard LEDs. Ground is supplied through the proper switch to light the proper LED. The LED control circuits are the "B" halves of switches 1A and 2A in the time interval circuit, therefore, they share control inputs with switch 1A and 2A shown in Figure 606-1.

606-15. Block Diagram Analysis

606-16. Refer to Figure 606-1. The time base circuitry provides four basic times, but all selection and control stems from the key select circuit. The key select circuit includes a 16-key encoder, a buffer inverter and a gate circuit. Active low signals generated within the 16-key encoder are outputs at X1, X2, X3, and X4. These outputs are routed to the Keyboard through P10-J10. Refer to the keyboard schematic, Figure 606-3. For discussion purposes, assume that the 10 second key and the X2 key have been pushed to produce a 20 second print interval. Key Encoder output X1 is supplied, through two switches, to both the Y2 and Y3 inputs of the key encoder.

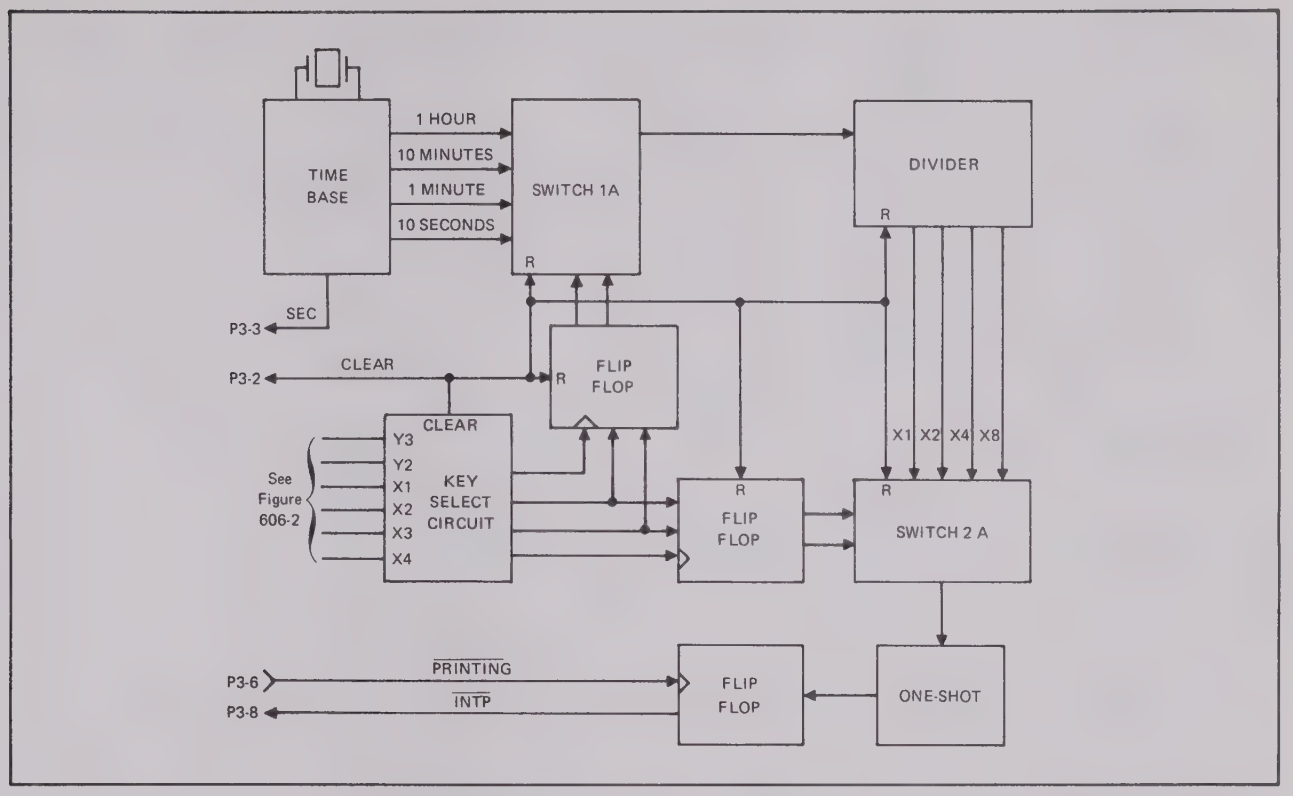


Figure 606-1. Block Diagram - Interval Time Control

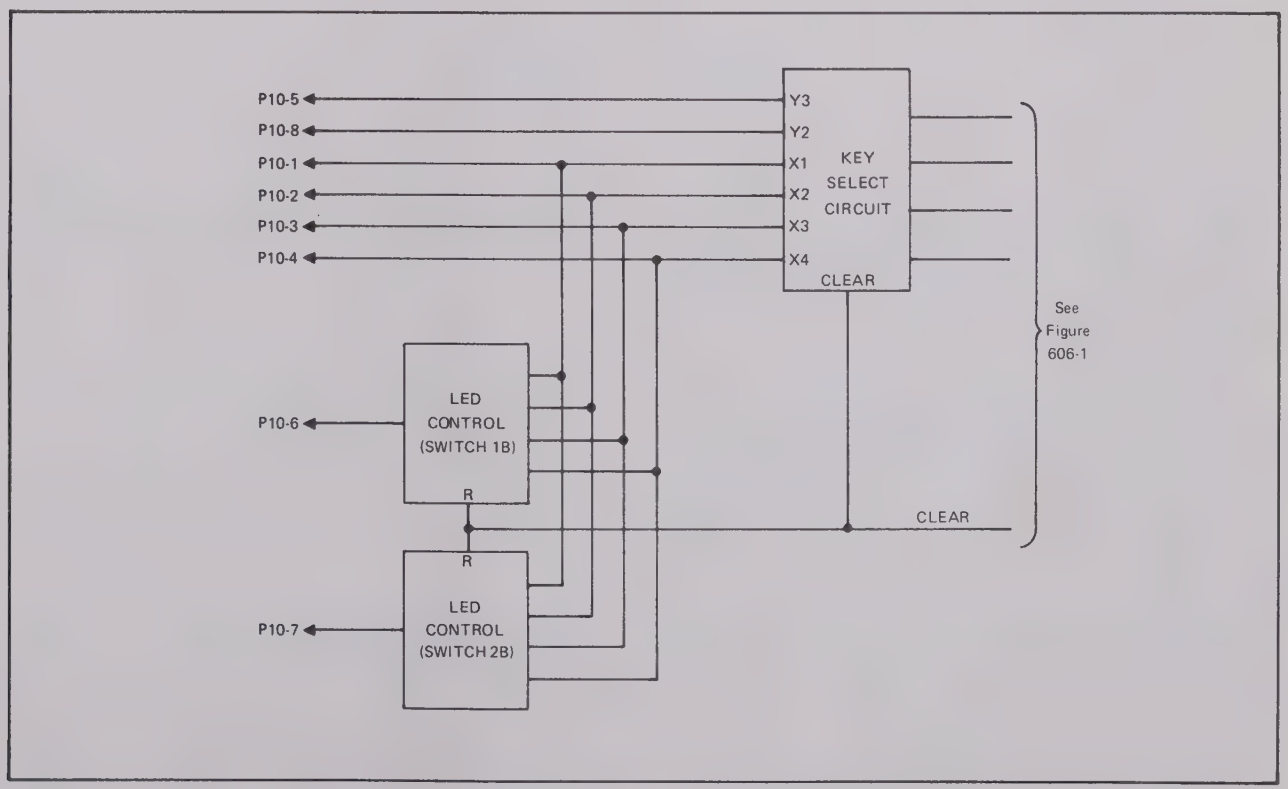


Figure 606-2. Block Diagram - LED Control

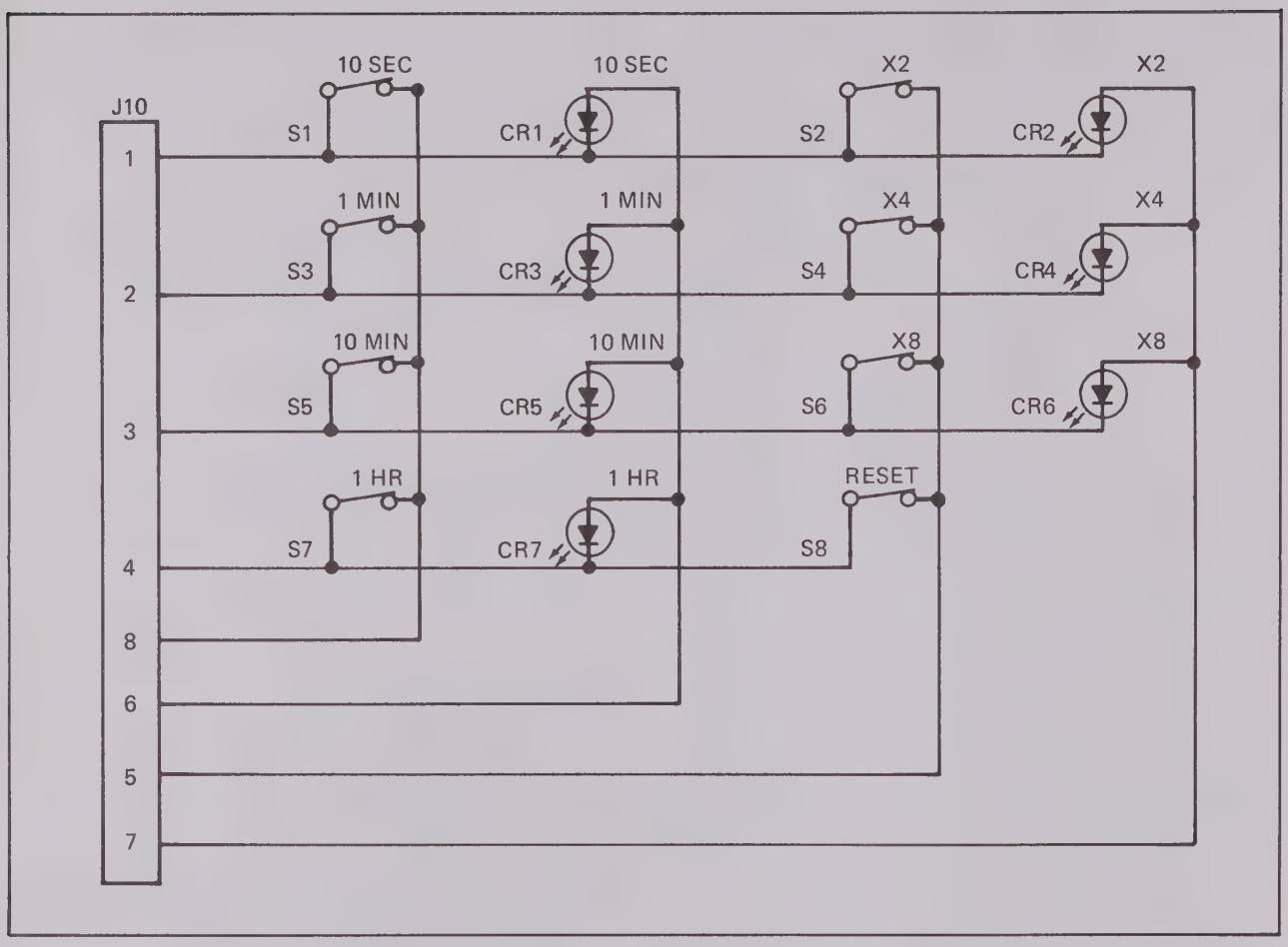


Figure 606-3. Keyboard Schematic

606-17. Internally, the key encoder uses the Y2 and Y3 inputs to produce C and D outputs; A, B, and Data Available (DAV) outputs are produced internally also. DAV is true at all times when a key is pushed. Refer to Table 606-3. The A, B, C, and D outputs are supplied through key encoder internal logic.

Table 606-3. Key Encoder Outputs

	D	C	B	A
10 SEC	0	1	0	0
1 MIN	0	1	0	1
10 MIN	0	1	1	0
1 HOUR	0	1	1	1
X2	1	0	0	0
X4	1	0	0	0
X8	1	0	1	0
RESET	1	0	1	1

606-18. Key encoder outputs, through AND gates, control two flip-flop circuits. The two flip-flops control switch 1 and switch 2, two electronic switching devices, which select one of four inputs to supply at the output.

606-19. Inputs to switch circuit 1A are the four basic times from the time base generator. Under control of the key select circuit, as established from the keyboard, switch 1A selects one basic time signal and routes it to a divider circuit. The divider circuit is a seven stage binary counter, configured such that its outputs are the base time input plus multiples of two, four, and eight times that basic frequency.

606-20. Divider circuit outputs are the four inputs to switch circuit 2A. Switch circuit 2A, also under control of the key select circuit as established from the Keyboard, selects either the basic time signal or one of its multiples (X2, X4, X8) for output to a one-shot circuit. The one-shot circuit triggers a flip-flop circuit which supplies an Interval Print (INTP) command, through the interface, to the 2020A microcomputer. When the microcomputer

starts printing, it generates a PRINTING signal which is used to reset the flip-flop.

606-21. In addition to providing control codes to generate INTP signals at the proper intervals, the key select circuitry controls keyboard LEDs to indicate the interval selected. Refer to Figure 606-2. LED control, as is the INTP signal, is initiated through the Keyboard. The same key select circuit outputs, through the same two flip-flop circuits, control the LEDs. Section "B" of switch circuit 1 controls the time interval LEDs, and section "B" of switch circuit 2 controls the multiplier LEDs.

606-22. Refer to Figure 606-3, the keyboard schematic. A direct path, through an LED, exists between J10 pin 6, and J10 pins 1, 2, 3, and 4. Key select circuitry provides ground level pulses at pins 1, 2, 3, and 4. When a switch is closed, these low logic pulses will be directed to pin 8, and through pin 8 to the Y2 key select circuit input. Within the key select circuit, coincidence between an "X" and "Y" signal produces an output code unique to coincidence between those two signals. The key select output code, through the flip-flops, directs switch circuits 1B and 2B to select the proper input (X1, X2, X3, X4) to supply at its output. Switch circuit outputs, both 1B and 2B, supply +5V pulses on P10, pins 6 and 7. The +5V pulses will be coincident with the ground pulses selected through one closed key, and the coincident ground and +5V pulses will light the proper LED.

606-23. As can be seen in Figure 606-3, the RESET switch (S8) has no LED connected to it. The absence of any other LED indication means that the print interval circuitry is in a reset (clear) condition. When the RESET switch is closed, it initiates a key select circuit output which resets all Interval Print control circuits. A Clear signal is also supplied to the interface through P3 pin 2. If the PTI Interface is installed, the Clear signal resets the elapsed time clock in the PTI Interface.

606-24. A Clear signal is also generated upon power up. This is accomplished through use of the Reset generated on the 2020A Printer PCB. A Reset input turns on a transistor (part of the switch select circuit) which produces a closure between pins 4 and 5 of P10 electronically, just as the RESET switch does mechanically.

606-25. MAINTENANCE

606-26. Refer to Section 4 of this manual for service information, cleaning instructions, and general maintenance instructions.

606-27. Performance Test

606-28. Interval Timer performance is best tested with the option installed in a known good 2020A Printer. The following procedure may be used to test Interval Timer performance.

1. Press 2020A POWER switch.

2. Press the 10 SEC interval switch. The 2020A Printer will print information at 10 second intervals.

NOTE

The first print cycle may be as much as 1 second early, depending on where, within its cycle, the clock was at initialization.

3. Press the X2 multiplier switch. The 2020A Printer will print information at 20-second intervals.

4. If the PTI Interface is installed, elapsed time should be printed during each print cycle.

5. Push the RESET switch, then push the 10 SEC switch.

6. Check the next elapsed time printout. It should have been reset when RESET was pushed.

7. If the Interval Timer does not perform correctly, refer to the Troubleshooting Guide, Table 606-4.

8. Check the remaining print intervals and multipliers in a similar manner.

606-29. Calibration Adjustments

606-30. The Interval Timer does not require periodic or post-repair calibration adjustment.

606-31. Troubleshooting

606-32. Troubleshooting information presented in Table 606-4 is intended as a guide to assist in malfunction isolation. When a step on the tabular flow chart is complete, check for a decision transfer. If no decision is required, perform the next step in the table in sequence.

606-33. LIST OF REPLACEABLE PARTS

606-34. A list of replaceable parts for the Interval Timer is given in Table 606-5 and 606-6. Refer to Section 5 of this manual for ordering information.

CAUTION

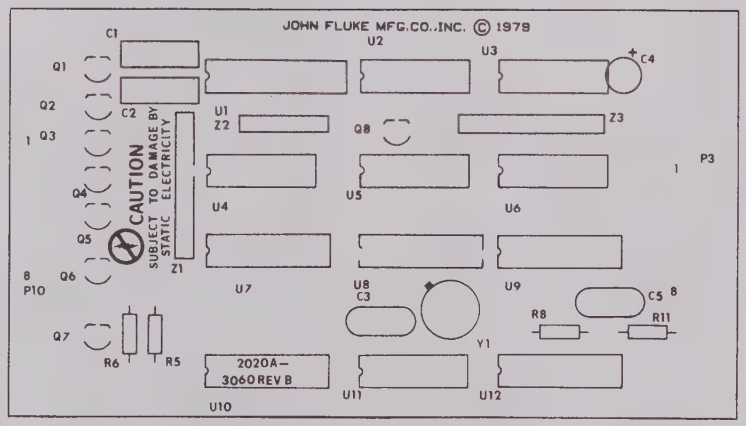
Indicated devices are subject to damage by static discharge.

Table 606-4. Interval Timer Troubleshooting Guide

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do all intervals fail to function?	3	2
2	Check the inverter, transistor, and switch applicable to the malfunctioning interval. (Refer to Section 8, 2020A-1060.)		
3	Are time base outputs present at U7, pins 3, 4, 5, and 6?	5	4
4	Check the time base circuitry.		
5	Do key select circuit outputs at U7, pins 1, 2, and 14 vary as different keys are pressed?	7	6
6	Check the key select circuit.		
7	Are interval pulses (10 SEC, 1 MIN, 10 MIN, 1 HR) present at U11, pin 1?	9	8
8	Check switch 1A (U7).		
9	Do key select circuit outputs at U10, pins 14 and 2 change as different keys are pressed?	10	6
10	Does the output pulse at U10, pin 7 occur at the time interval selected?	12	11
11	Check the Divider circuit.		
12	Is the INTP pulse present at P3, pin 8?	14	13
13	Check the flip-flop and one shot circuits.		
14	Do the interval LEDs function properly?	16	15
15	Check switch 1B and transistor Q6.		
16	Do the multiplier LEDs function properly?	18	17
17	Check switch 2B and transistor Q7.		
18	Does RESET from the 2020A microcomputer initiate a CLEAR?	20	19
19	Check transistor Q5.		
20	Interval Timer Assembly troubleshooting is complete.		

Table 606-5. Interval PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	⊗INTERVAL PCB ASSEMBLY OPTION -006 FIGURE 606-4 (2020A-4060)	ORDER	BY	OPTION -006			
	KEYBOARD ASSEMBLY	ORDER	NEXT	HIGHER ASSEMBLY -006			
C1	CAP, PLYSTRN, 0.010 UF +/-10%, 250V	325548	73445	C280MA3/A10K	1		
C2	CAP, PLYSTRN, 0.10 UF +/-10%, 100V	393439	73445	C280MAH/A100K	1		
C3	CAP, MICA, 10 PF +/-10%, 500V	175216	72136	DMC15100K	1		
C4	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	1		
C5	CAP, MICA, 39 PF +/-5%, 500V	148544	72136	DMF15390J	1		
MP3	SPACER, XSTR, MTG.	152207	07047	10123-DAP	1		
P3	CONNECTOR, BD MNT	267633	00779	87022-2	8		
P10	CONNECTOR, POST	520593	00779	8586-3	8		
Q1	XSTR, SI, NPN	218396	04713	2N3904	7		
Q2	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q3	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q4	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q5	XSTR, SI, PNP	195974	04713	2N3906	1	1	
Q6	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q7	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q8	XSTR, SI, NPN	218396	04713	2N3904	REF		
R6	RES, DEP. CAR, 75 +/-5%, 1/4W	441642	80031	CR251-4-5P75E	REF		
R8	RES, COMP, 22M +/-5%, 1/4W	221986	01121	CB2265	1		
R11	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
U1	⊗IC, C-MOS, 16 KEY ENCODER	483925	12040	MM74C922N	1	1	
U2	⊗IC, C-MOS, DUAL TYPE "D" F/F	340117	04713	MC14013CP	3	1	
U3	⊗IC, C-MOS, TRI-3-INPUT NAND GATES	375147	04713	MC14023CP	1	1	
U4	⊗IC, C-MOS, HEX INVERTER	404681	04713	MC1406BCP	1	1	
U5	⊗IC, C-MOS, DUAL TYPE "D" F/F	340117	04713	MC14013CP	REF		
U6	⊗IC, C-MOS, DUAL TYPE "D" F/F	340117	04713	MC14013CP	REF		
U7	⊗IC, C-MOS, DUAL 4-CHANNEL	507632	04713	MC14539BCP	2	1	
U8	⊗IC, C-MOS, TIME BAS GENERATOR	404251	04713	MC14566CP	2	1	
U9	⊗IC, C-MOS, TIME BAS GENERATOR	404251	04713	MC14566CP	REF		
U10	⊗IC, C-MOS, DUAL 4-CHANNEL	507632	04713	MC14539BCP	REF		
U11	⊗IC, C-MOS, 7-STAGE BINARY COUNTER	412965	04713	MC14024CP	1	1	
U12	⊗IC, C-MOS, 12-STAGE, BINARY COUNTERS	507640	12040	CD4060BCN	1	1	
Y1	CRYSTAL	519132	89536	519132	1		
Z1	RESISTOR, NETWORK, 10K	513309	89536	513309	2		
Z2	RESISTOR NETWORK, 10K	500876	89536	500876	1		
Z3	RESISTOR, NETWORK, 10K	513309	89536	513309	REF		

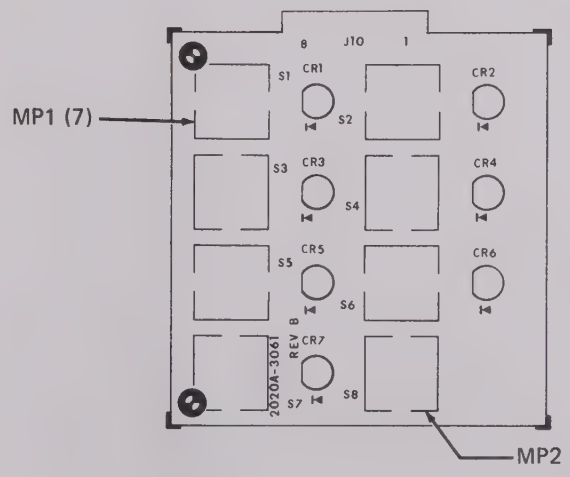


2020A-1660

Figure 606-4. Interval PCB Assembly

Table 606-6. Keyboard Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	KEYBOARD ASSEMBLY FOR -006 OPTION FIGURE 606-5 (2020A-4061)	SEE	-006	OPTION	REF		
CR1	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	7		
CR2	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	REF		
CR3	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	REF		
CR4	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	REF		
CR5	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	REF		
CR6	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	REF		
CR7	DIODE, LIGHT EMITTING, ORANGE	413831	29083	MV5153	REF		
J10	CONNECTOR, POST	513861	00779	1-87022-0	8		
MP1	BUTTON, PUSH, BLK	457390	89536	457390	7		
MP2	BUTTON, PUSH, BLUE	406736	89536	406736	1		
MP3	SPACER, COMPONENT (NOT SHOWN)	296319	32559	TO-8-06	7		
S1	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	8		
S2	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		
S3	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		
S4	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		
S5	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		
S6	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		
S7	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		
S8	SWITCH, MOMENTARY, NON-LIGHTED	507319	89536	507319	REF		



2020A-1661

Figure 606-5. Keyboard Assembly

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(–) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmablle read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

Federal Supply Codes for Manufacturers (cont)

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey
70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303
72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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Suite 96
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(205) 881-6220

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Suite 104
Tempe, AZ 85282
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Carson, CA 90746
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or (714) 761-2449

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Santa Clara, CA 95051
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San Diego, CA 92123
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Tustin, CA 92680
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John Fluke Mfg. Co., Inc.
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Denver, CO 80231
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FL, Orlando
John Fluke Mfg. Co.,Inc.
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2700 Delk Rd., Suite 250
Marietta, GA 30067
(404) 953-4747

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EMC Corporation
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Honolulu, HI 96819
(808) 836-1138

IA, Iowa City
(319) 354-2811

IL, Chicago
John Fluke Mfg. Co., Inc.
3740 Industrial Ave.
Rolling Meadows, IL 60008
(312) 398-0850

IN, Indianapolis
John Fluke Mfg. Co., Inc.
5610 Crawfordsville Rd.
Suite 802
Indianapolis, IN 46224
(317) 244-2456

KS, Kansas City
John Fluke Mfg. Co., Inc.
4550 W. 109th St., Suite 130
Shawnee Mission, KA 66211
(913) 381-9800

LA, New Orleans
(504) 455-0814

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John Fluke Mfg. Co., Inc.
25 "B" Street
Burlington MA 01803
(617) 273-4674

MD, Baltimore
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John Fluke Mfg. Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
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Livonia, MI 48154
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Apple Valley, MN 55124
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MO, St. Louis
John Fluke Mfg. Co., Inc.
300 Brookes Dr., Suite 100
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(314) 731-3388

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Albuquerque, NM 87110
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Rochester, NY 14622
(716) 266-1400

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(216) 234-4540

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PA, Philadelphia
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(215) 265-4040

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8705 Shoal Creek Blvd.
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Dallas, TX 75234
(214) 233-9990

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Stafford, TX 77477
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San Antonio, TX 78216
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John Fluke Mfg. Co., Inc.
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(801) 268-9331

WA, Seattle
John Fluke Mfg. Co., Inc.
975 Industry Drive
Seattle, WA 98188
(206) 575-3765

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CA, Santa Clara (408) 727-8121
CO, Denver (303) 750-1228
FL, Orlando (305) 896-2296
IL, Chicago (312) 398-5800
MA, Burlington (617) 273-4678
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Digital Counters: 1900A, 1910A, 1911A, 1912A
Digital Thermometers: 2160 - and 2170 - Series

All other instruments are sold by the sales offices only.

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Elmeasco Instruments Pty Ltd.
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Australia
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Elmeasco Instruments Pty Ltd.
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Elmeasco Instruments Pty Ltd.
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P.O.Box 95, Gosnells
West Australia 6110
Tel: (09) 398-3362

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Elektronische Gerate GmbH & Co.
Liechtensteinstrasse 97/6
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Tel: (0222) 235555, TLX: 134759

Bangladesh ●
Motherland Corporation
24 Hatkhola Rd., Tikatuli
Dacca 3, Bangladesh
Tel: 257249

Belgium ■
Fluke (Belgium) S.A./N.V.
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1140 Brussels, Belgium
Tel: (2) 2164090, TLX: 26312

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Coasin Bolivia S.R.L.
Casilla 7295, La Paz, Bolivia
Tel: 40962, TLX: 5255

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Fluke Brasil-Industria E
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Alphaville, Barueri,
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Mile 1, Jalong Tutong
Bandar Seri Begawan, Brunei
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Staines, Middlesex TW18 45Y
United Kingdom
Tel: (784) 63555, TLX: 928855

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Attn: Intronica Chile

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TLX: 152662 JOHN FLUKE EVT

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AWA Fiji
47 Forster Road, Walu Bay
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Oy Findip AB, Teollisuustie 7
02700 Kauniainen, Finland
Puh: (0) 5052255, TLX: 123129

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M.B. Electronique S.A.
Rue Fourny 606, Z1 Centre
78530 BUC
B.P. No. 31
78530 BUC, France
Tel: (3) 9568131, TLX: 695414

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4000 Dusseldorf 30, West Germany
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Tel: 815344, TLX: 112326 Hspl In

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Shantiniketan, Office No.6
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204-206 Hemkunt Tower
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Naven County Meath, Ireland
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Israel ■
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Ramat Hasharon 47235, Israel
Tel: (3) 483212, TLX: 32143

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Sistrel S.p.A.
Via Pelizza da Vilpedo 59
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38 FL Shinjuko Nomura Bldg.
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Tokyo 160, Japan
Tel: 03-343-4411, TLX: 2322220

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Jung-ku
Seoul, Korea
Tel: 261-7702, TLX: K25381

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Kuwait, Arabian Gulf
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Tel: 566599
TLX: OCONOR MA37649

Rank O'Connor's (PTE) Limited
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Mile 3, Jalan Penampang
Kota Kinabulu, East Malaysia
Tel: 55329, TLX: MA80286

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Pafnucio Padilla 53
Circuito Comorcial Satelite
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TLX: 1773613

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Associated Enterprises
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McLean Information Technology, Ltd.
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Nigeria ●
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Lagos, Nigeria
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Morgenstierne & Co A/S
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Pak International Operations
505 Muhammadi House
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Tel: 221127, TLX: 24494

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Appendix 7A
Manual Change Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table 7A-1.

CHANGES

There are no backdating changes at this printing. All pcb assemblies are documented at their original revision level.

Table 7A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	*To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with change under desired rev letter.																							
			–	A	B	C	D	E	F	G	H	J	K	L	M	N	P									
A1	Printer, Main PCB Assembly	490128					X																			
A2	Printer Mechanism Assembly	490060	–																							
A2A1	Printer Mechanism Interconnect Assembly	521047	–																							
-001	Parallel ASCII Interface PCB Assembly	501908					X																			
-002	RS-232-C Interface PCB Assembly	490425			X																					
-003	IEEE-488 Interface Assembly	501932			X																					
-004	PTI Interface Assembly	501965		X																						
-005	Parallel BCD Interface Assembly	501999		X																						
-006	Interval PCB Assembly	508661		X																						
-006	Keyboard PCB Assembly	509067		X																						

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
–= No revision letter on the PCB.

Section 8
Schematic Diagrams

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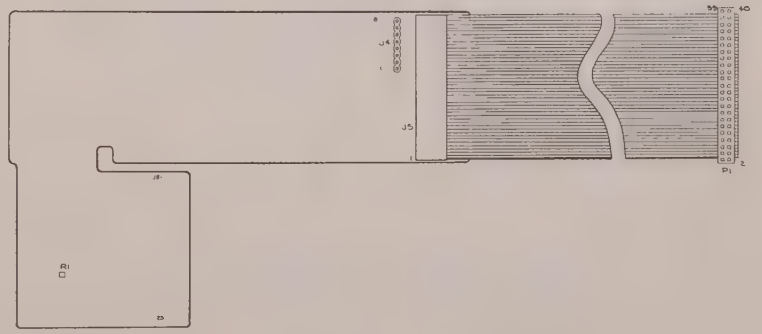
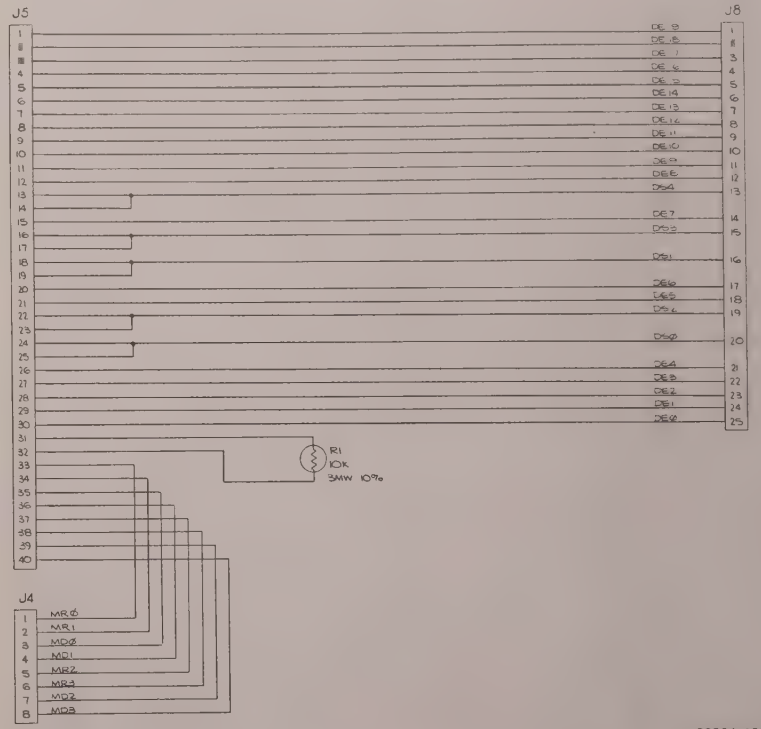
AB	Signal Ground
ACK	Acknowledge
ADR 0-3	Address
ADRVL	Address Valid
ATN	Attention
BA	BUSY
CB	Clear to Send
CC	Data Set Ready
CF	Data Carrier Detector
CLEAR	Clear
CONT	Continuous Print
DATA 0-7	Data Bus
DE 0-19	Digit Enable
DI 01-08	Data In Bus
DOU	Digital Output Unit
DR	Data Ready
DS 0-4	Dot Strobe
DTACK	Data Acknowledge
DTVAL	Data Valid
EXT PRT	External Print
IFC	Interface Clear
INTP	Interval Print
MD 0-3	Motor Drive
MR 0-3	Motor Return
NDAC	Not Data Acknowledge
NRFD	Not Read For Data
PRINT	Print Command
PRINTING	Printing
REN	Remote Enable
RESET	Reset
SCNIP	Scan In Progress
SEC	Seconds
SENSE 1	To Printhead Thermistor
SENSE 2	To Printhead Thermistor
SINGLE	Single Print
SRQ	Service Request
TRIGGER	Trigger
TRIGGER	Inverted Trigger

Figure 8-1. Mnemonics

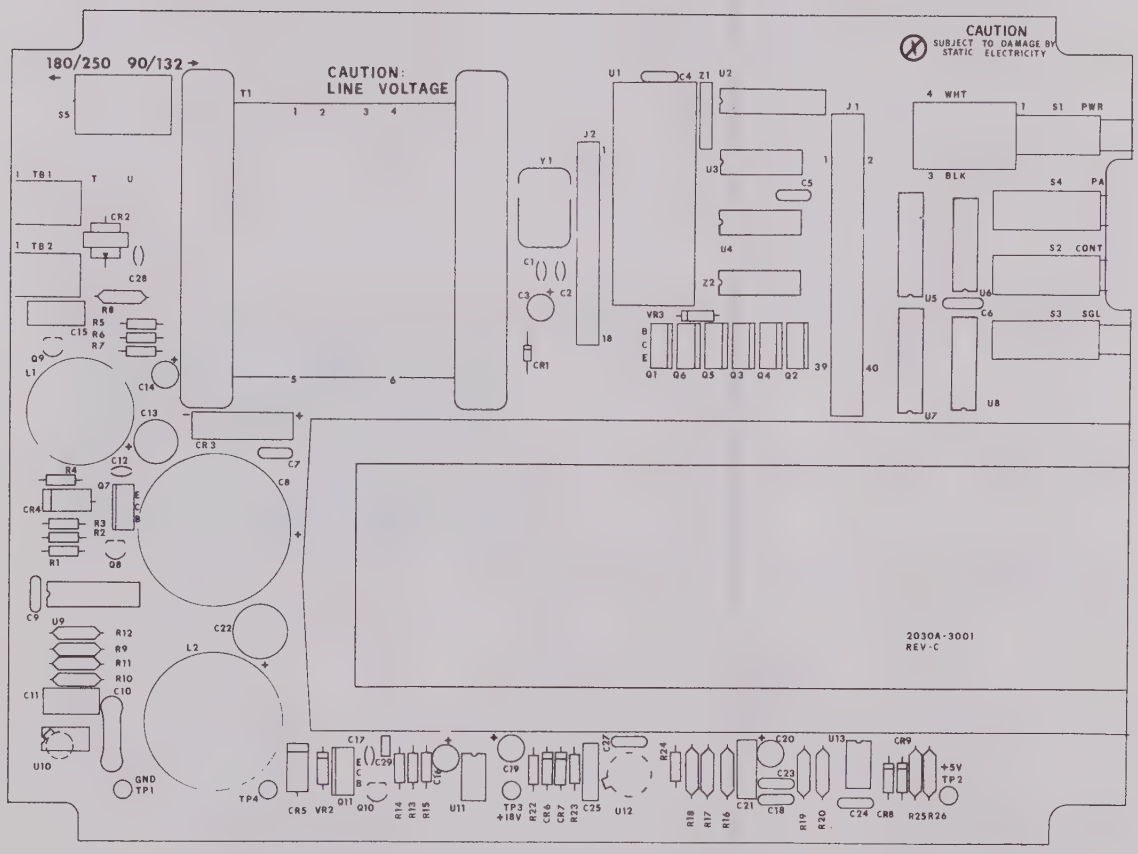


2020A-1604



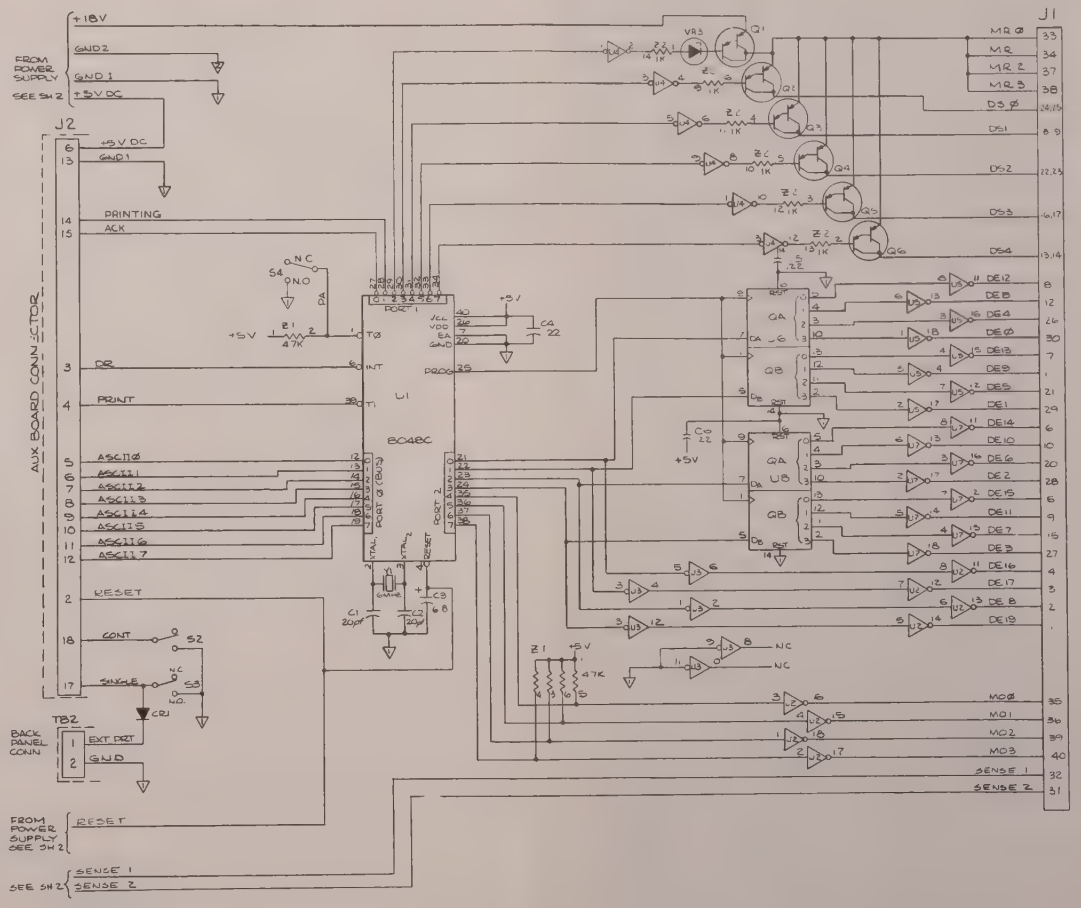
2030A-1004

Figure 8-2. A2A1 Interconnect Assembly



2030A-1601

Figure 8-3. Printer, Main PCB Assembly



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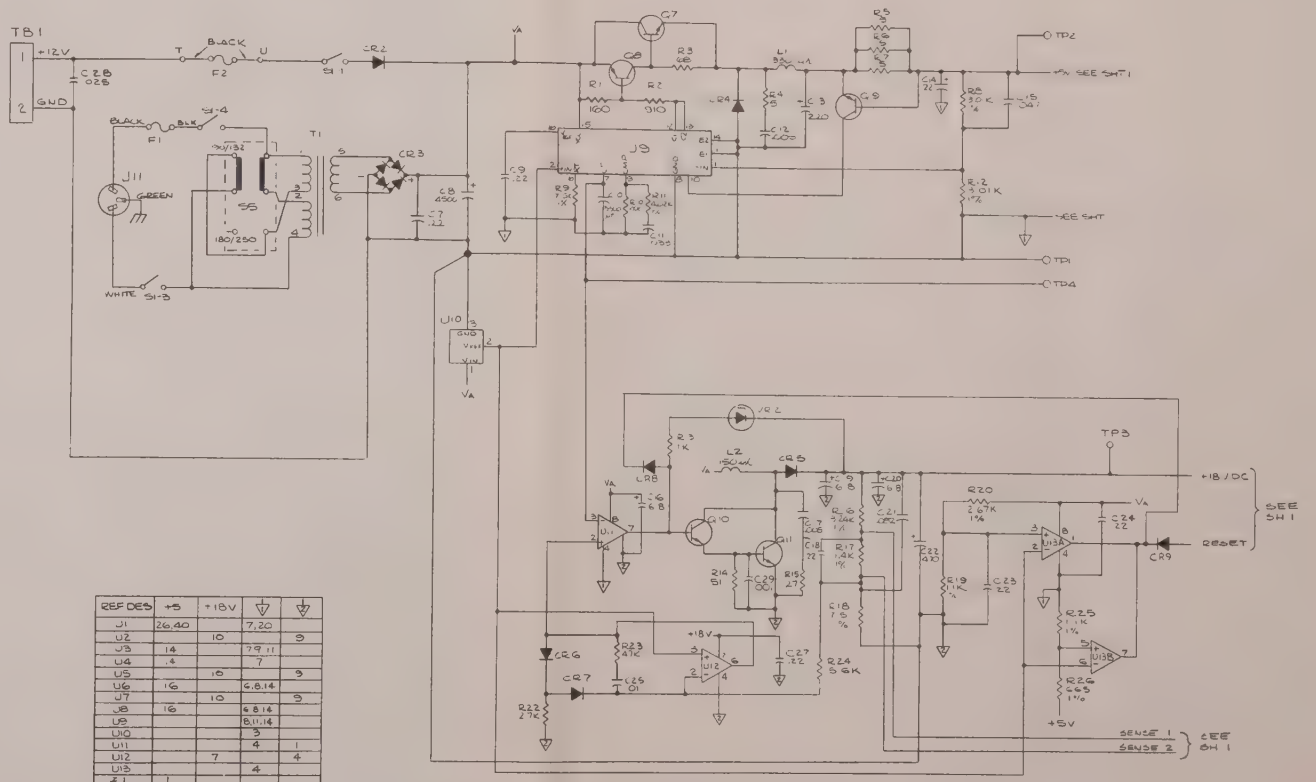
(1 OF 2)

Figure 8-3. Printer, Main PCB Assembly (cont)

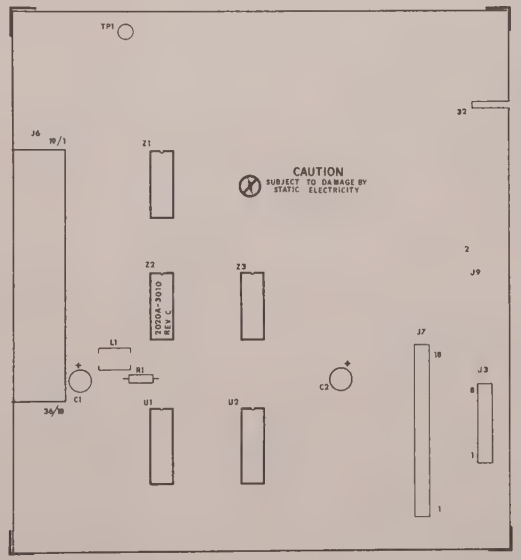


REF DES	+5	+18V		
J1	26,40		7,20	
U2		10		9
U3	14		7 9 11	
U4	4		7	
U5		10		9
U6	16		6,8,14	
U7		10		9
U8	16		4 8 14	
U9			8,11,14	
U10			3	
U11			4	1
U12		7		4
U13			4	
E1	1			

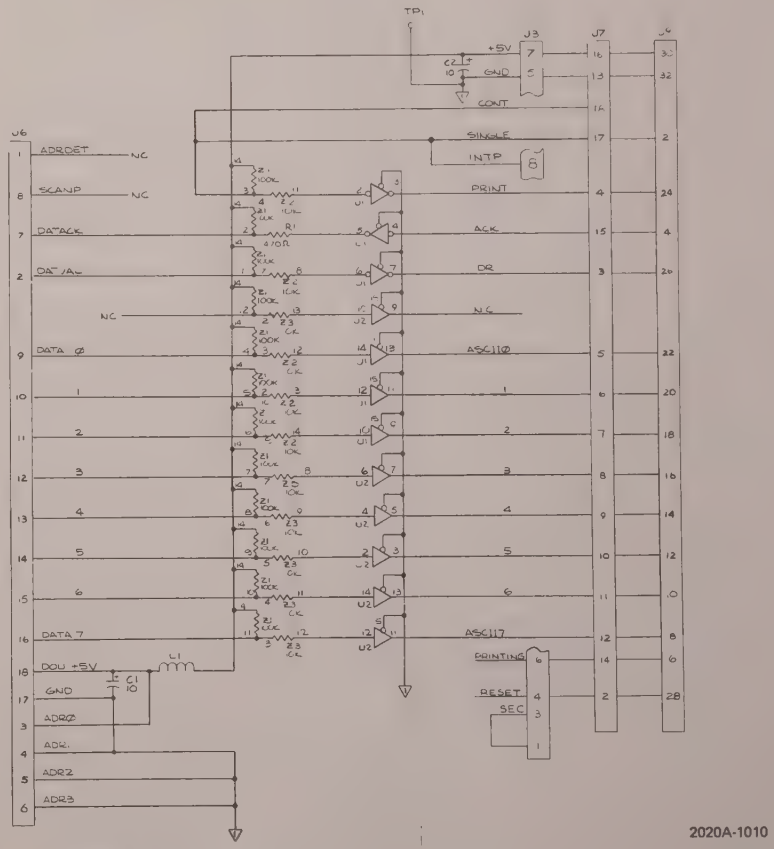
REF DES	
LAST USED	NOT USED
C29	R3
CR9	J1
F2	E2
L2	
Q11	TB2
R226	TP4
S5	J2
T1	
U13	

2030A-1001
(2 OF 2)

Figure 8-3. Printer, Main PCB Assembly (cont)



2020A-1610



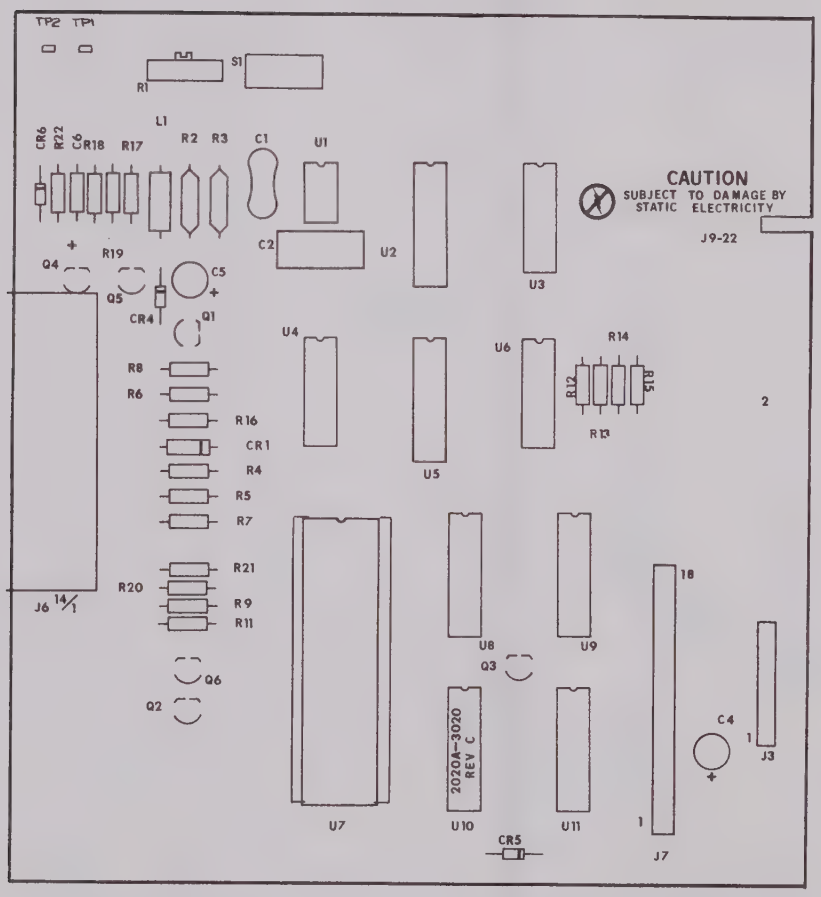
2020A-1010

REF DES	+5V	GND
U1	16	8
U2	16	8

NOTES: UNLESS OTHERWISE NOTED

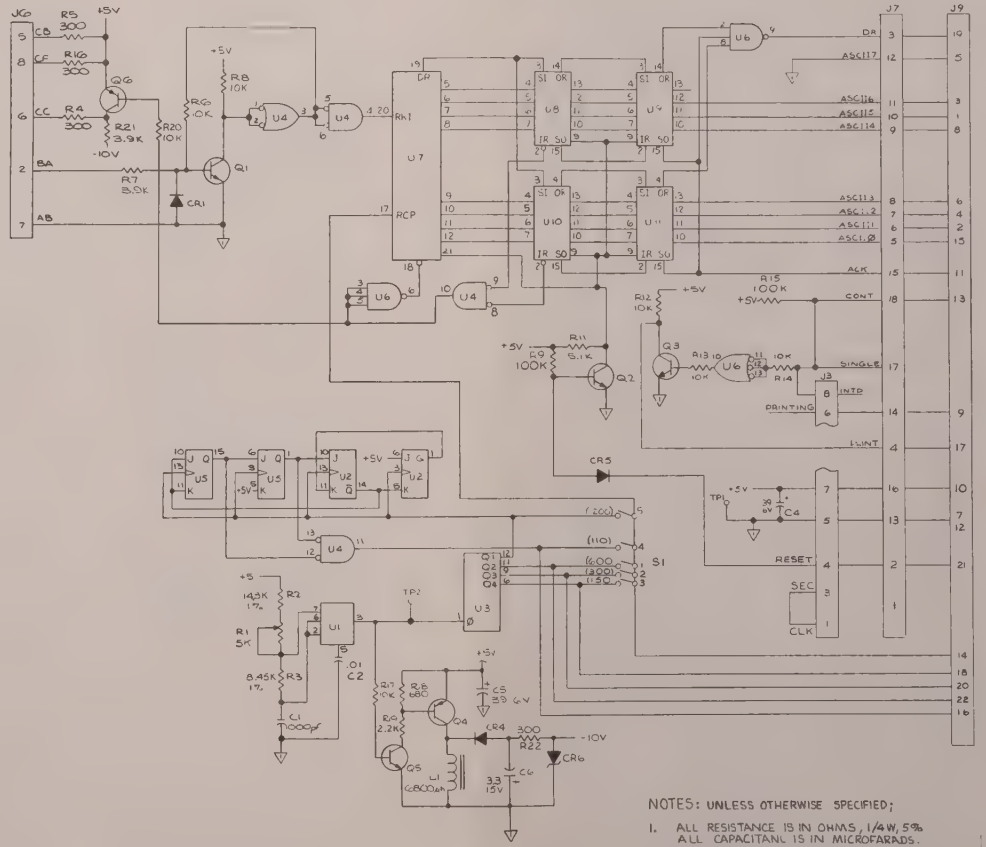
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14

Figure 8-4. Parallel ASCII Interface PCB Assembly



2020A-1620

Figure 8-5. RS-232-C Interface PCB Assembly

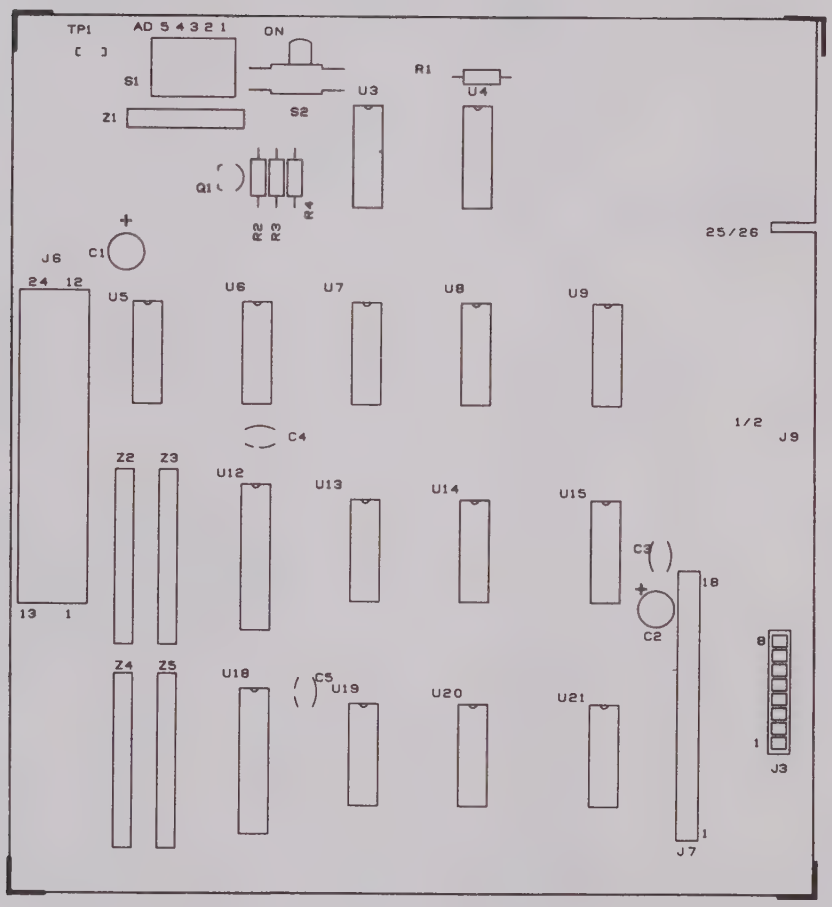

NOTES: UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTANCE IS IN OHMS, 1/4W, 5%
ALL CAPACITANCE IS IN MICROFARADS.
2. ALL GRAPHIC SYMBOLS ARE IN
ACCORDANCE WITH ANSI Y32.2 AND
Y32.14.

REF DES	+5V	GND
U1	8,4	1
U2	16	4,8,7,12,9
U3	14	2,7
U4	14	7
U5	16	4,8,7,9,12
U6	14	7
U7	1,37,39,34,40	34,36,35,38
U8	16	1,8
U9	16	1,8
U10	16	1,8
U11	16	1,8

REF DES
LAST USED
R22, C6, U11, Q6, CR6, S1
NOT USED
R10, C3, CR2,3

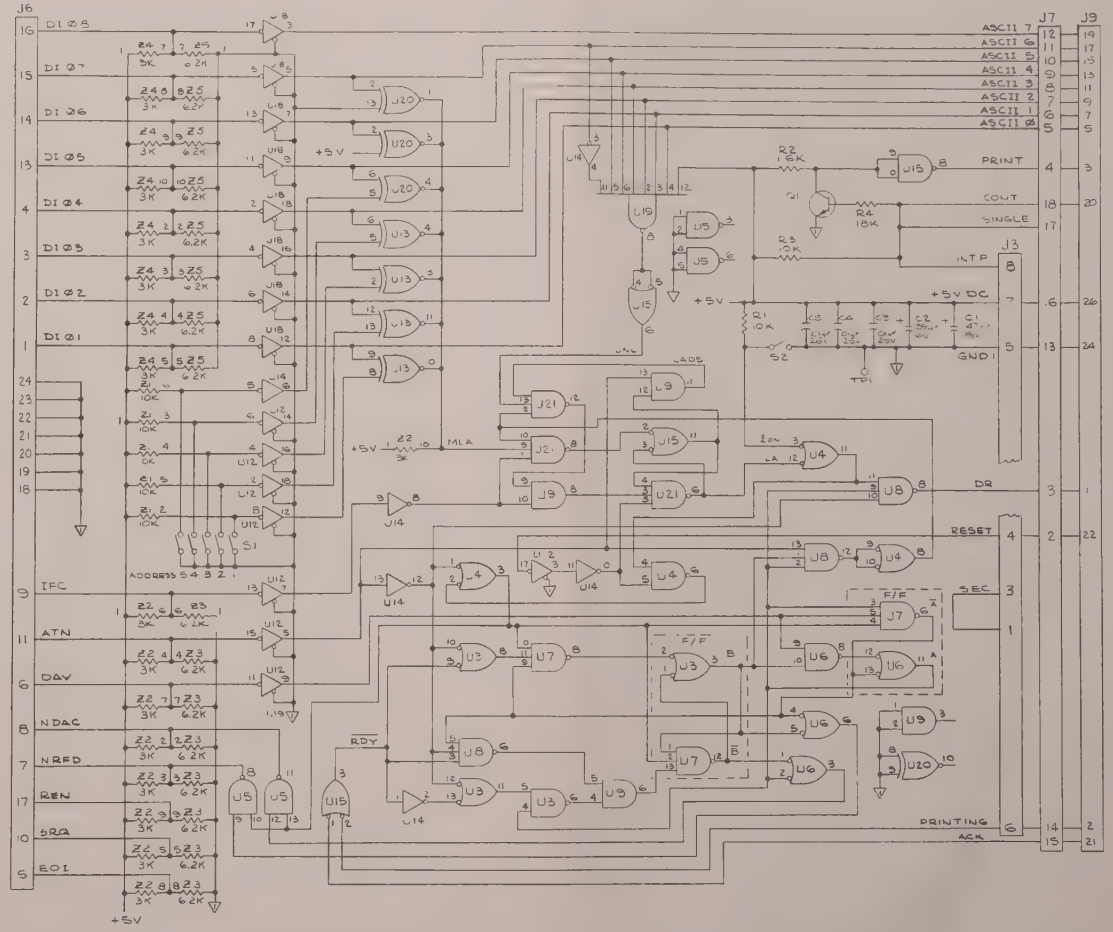
2020A-1020

Figure 8-5. RS-232-C Interface PCB Assembly (cont)



2020A-1630

Figure 8-6. IEEE-488 Interface PCB Assembly

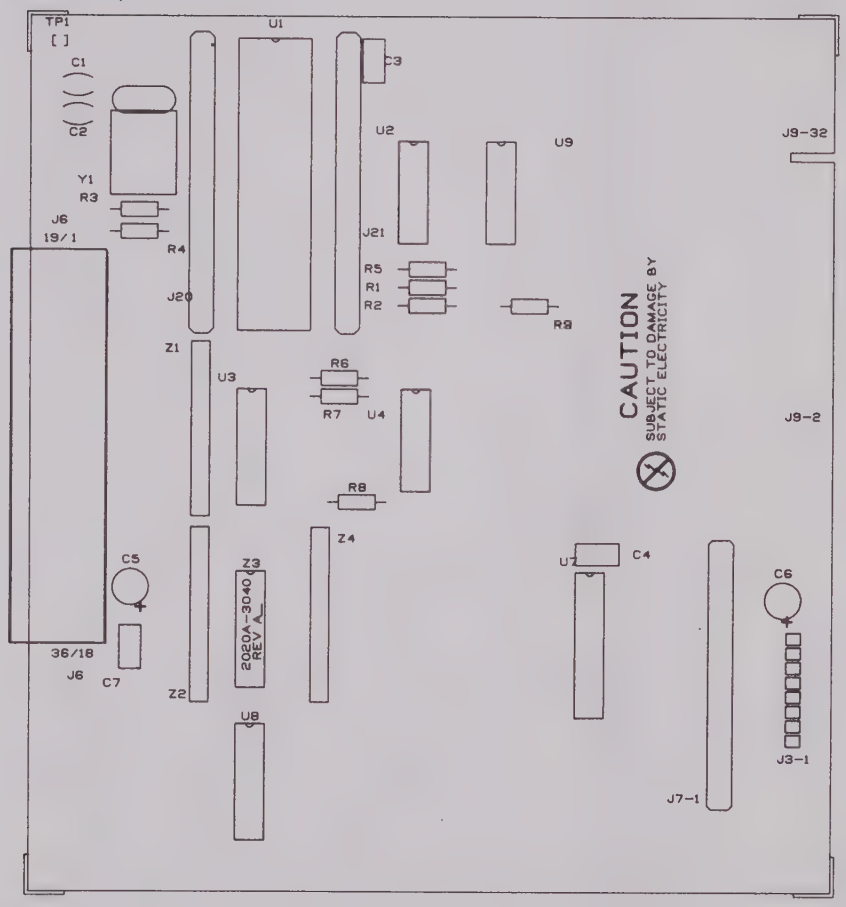


REF DES	+5V DC	GND
U3	14	7
U4	14	7
U5	14	7,4,5,12
U6	14	7
U7	14	7
U8	14	7
U9	14	7 ..2
U12	20	1,19 10
U13	4	7
U14	14	7
U15	14	7
U18	20	1,19,10
U19	12,14	7
U20	1,14	7,8,9,13
U21	14	7

REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C2 R4 U21 Q1 S2 J9 Z5	J1,2,6,11,16,17 J1,2,4,5,8

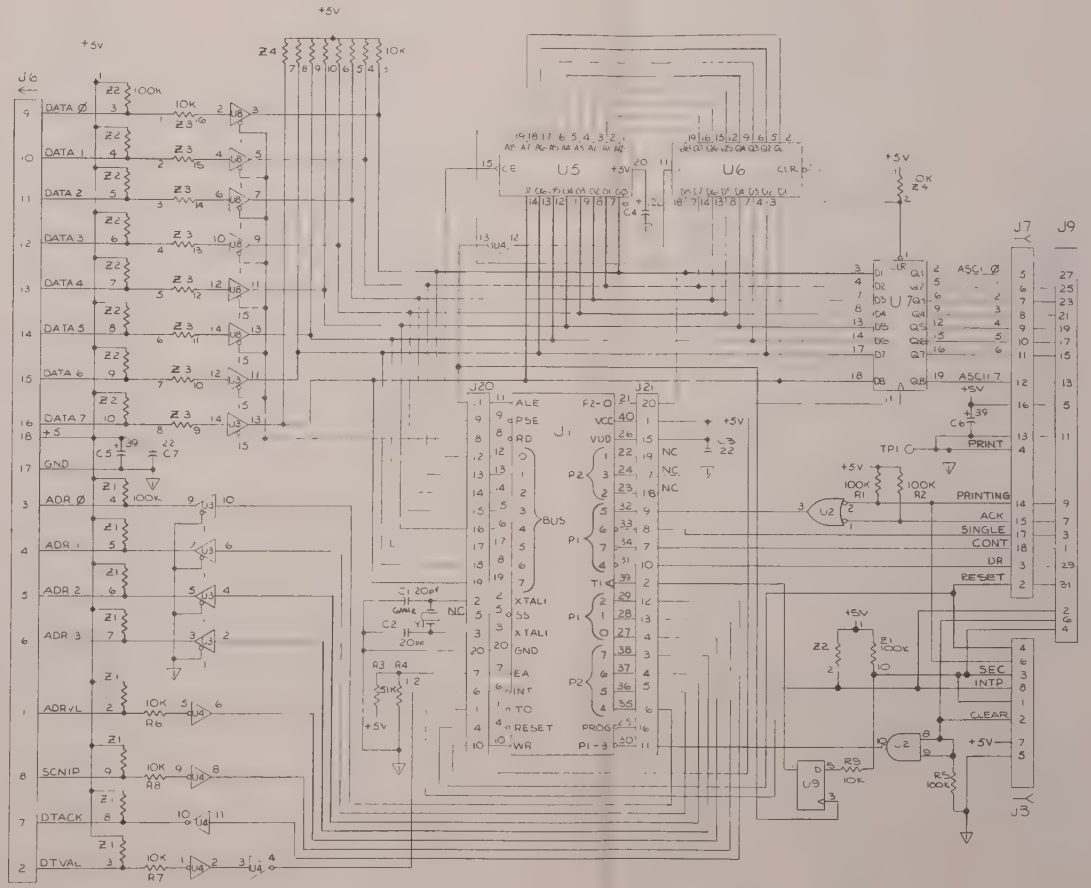
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE IS IN OHMS. ALL CAPACITANCE IS IN MICROFARADS
2. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14

Figure 8-6. IEEE-488 Interface PCB Assembly (cont)



2020A-1640

Figure 8-7. PTI Interface PCB Assembly



NOTES: UNLESS OTHERWISE SPECIFIED;

1. ALL RESISTANCE IS IN OHMS, 1/4W, 5%
   ALL CAPACITANC IS IN MICROFARADS.
2. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.

REF DES	GND	+5
	▽	+5V
U1	20	26,40
U2	5,6,7	12,13,14
U3	8	16
U4	7	14
U5	10	20
U6	10	20
U7	10	20
U8	8	16
U9	4,6,7,8,9,10,11	14

LAST USED
TP1, C7, U8, Y1
R9, Z4

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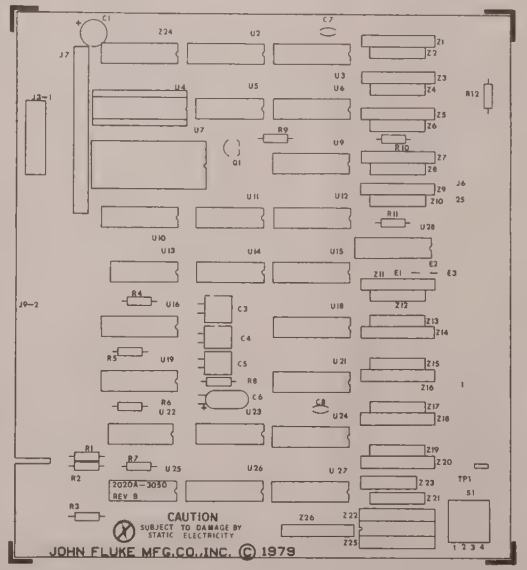
Figure 8-7. PTI Interface PCB Assembly (cont)

REF DES	GND	+5	REF DES	GND	+5
U1		1			
U2	8,9,10,15	14			
U3	8,9,10,15	16			
U4	10,15	16			
U5	7,4,5	14			
U6	8,9,10,15	16			
U7	12	4			
U8					
U9	8,9,10,15	16			
U10	8,9	16			
U11	7	14			
U12	8,9,10,15	16			
U13	6,7,8,9,10,11	14			
U14	7	14			
U15	8,9,10,15	16			
U16	8	3,5,11,13,16			
U17					
U18	8 and 5	16			
U19	8	3,5,11,13,16			
U20					
U21	8,9,10,15	16			
U22	7	14			
U23	5,7,8	14			
U24	8,9,10,15	16			
U25	7	14			
U26	8,9,10,15	16			
U27	8,9,10,15	16			
U28	8	1			

LAST USED
R12, C8, U28, Z26, Q1, S1, TP1

NOT USED
U1,8,17,20 C2

NOTES: UNLESS OTHERWISE NOTED:
1. ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4W, 5%.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.



2020A-1650

Figure 8-8. Parallel BCD Interface PCB Assembly

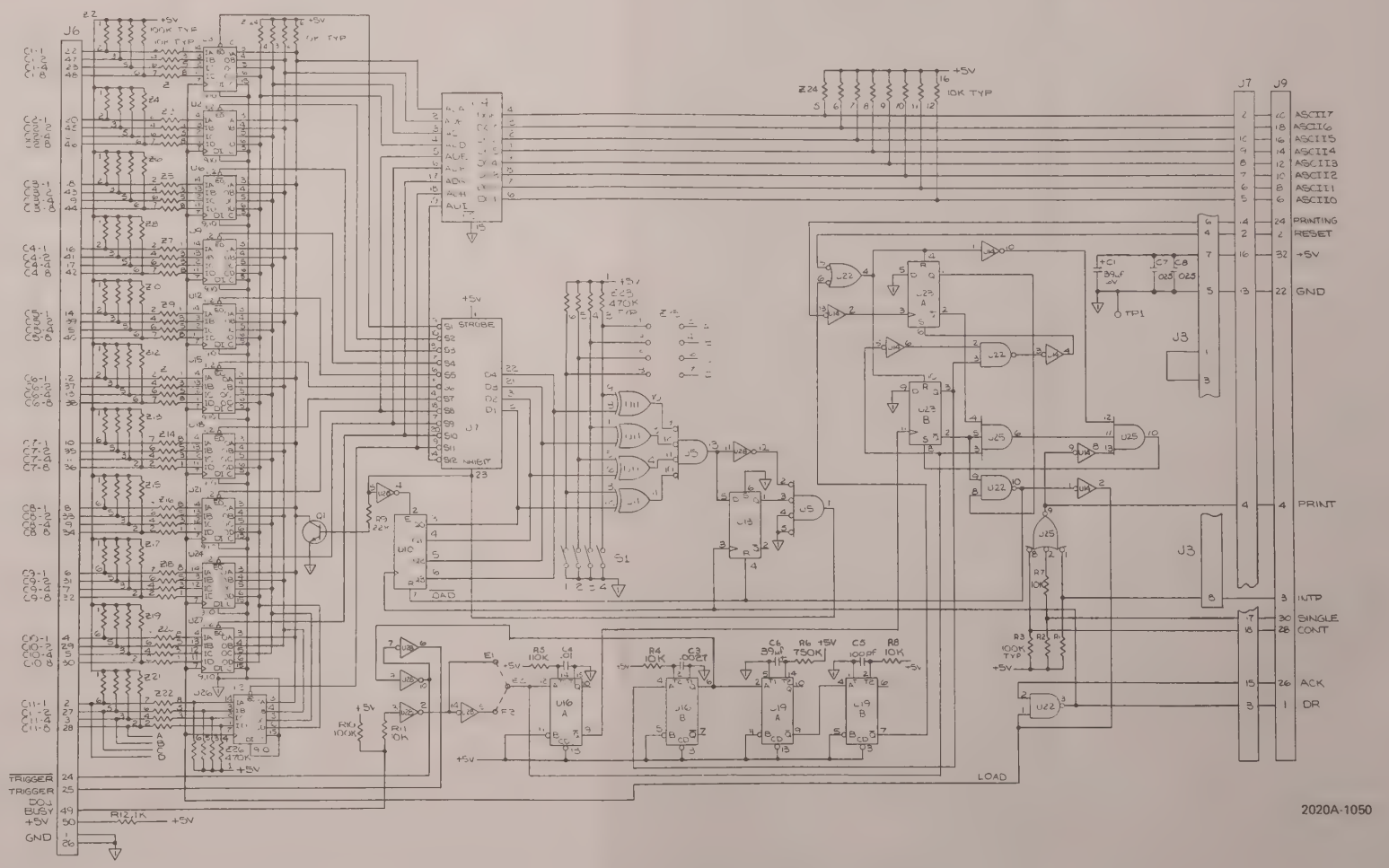
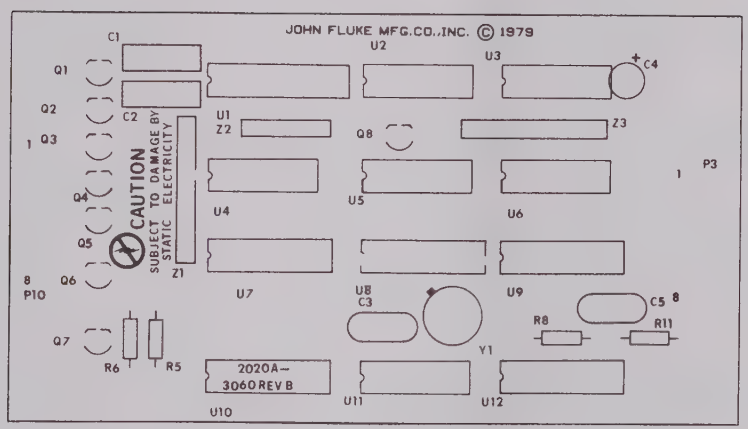
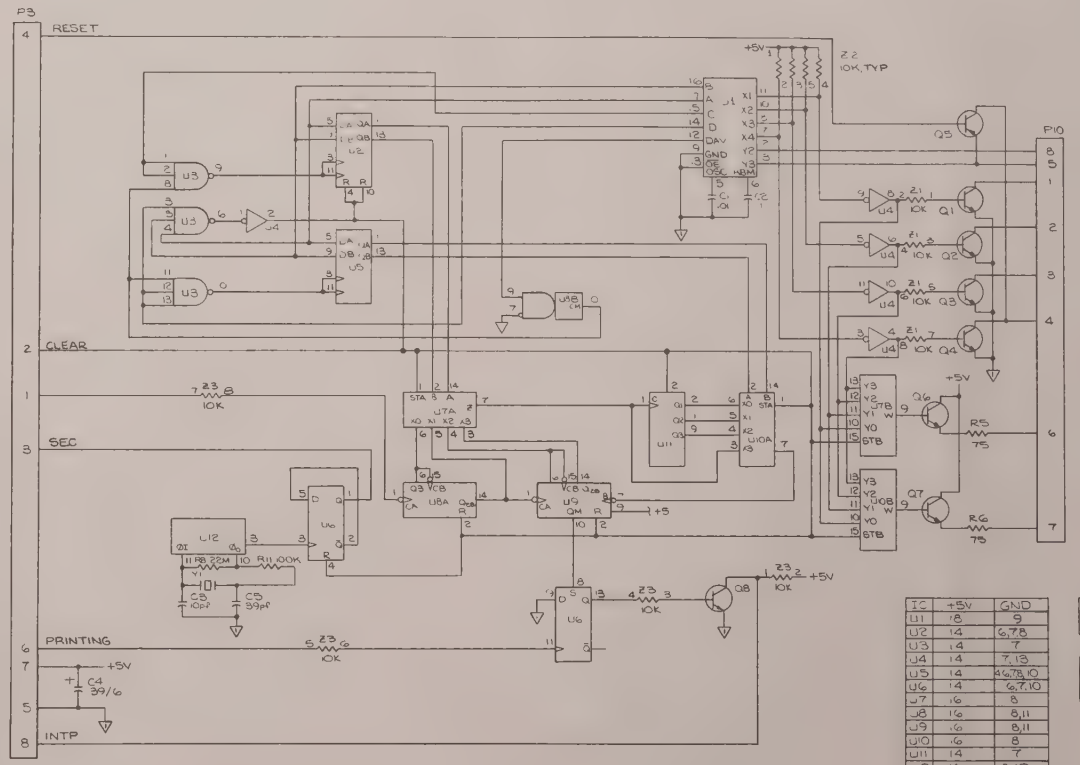


Figure 8-8. Parallel BCD Interface PCB Assembly (cont)



2020A-1660

Figure 8-9. Interval PCB Assembly



IC	+5V	GND
U1	18	9
U2	14	6,7,8
U3	14	7
U4	14	7, 13
U5	14	4,6,7,8,10
U6	14	6,7,10
U7	16	8
U8	16	8,11
U9	16	8,11
U10	16	8
U11	14	7
U12	16	8,12

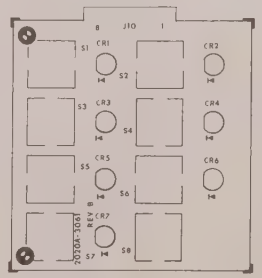
LAST USED
R11, Z3, C5, Q8, U12
Y1

NOT USED
R1-4, 7,9,10

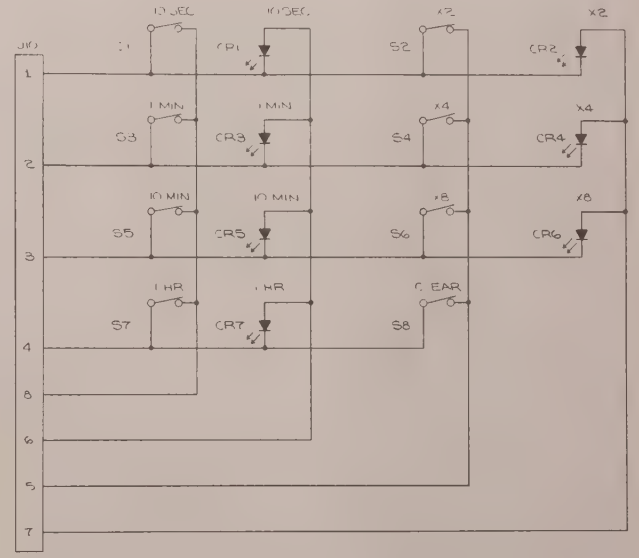
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4W, 5%
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32-14 AND Y32-2

2020A-1060

Figure 8-9. Interval PCB Assembly (cont)



2020A-1661



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL GRAPHIC SYMBOLS IN ACCORDANCE WITH ANSI-Y32-14 AND Y32-2.

2020A-1061

Figure 8-10. Keyboard Assembly

Application Bulletin

FLUKE

AB-40

INSTRUMENT PRINTING CONFIGURATION GUIDE

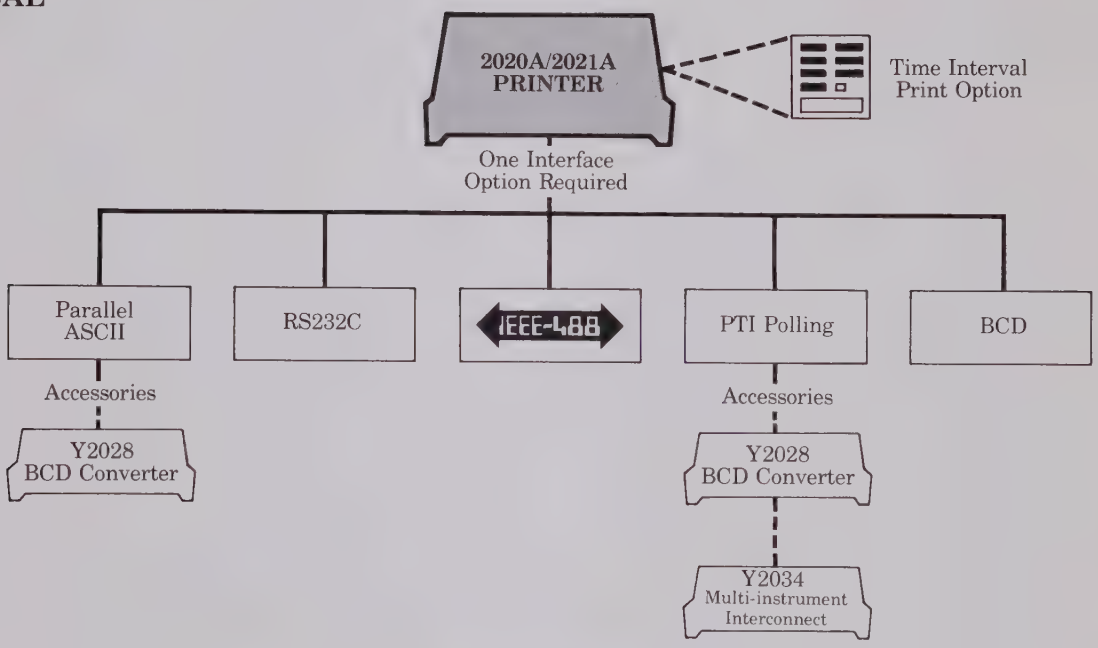
Interfacing measurement instruments to 2020A and 2030A PTI printers.

This guide is designed to provide all the information you need to configure instrument printing systems with Fluke measurement instruments and Fluke's 2020A, 2021A, and 2030A PTI printers.

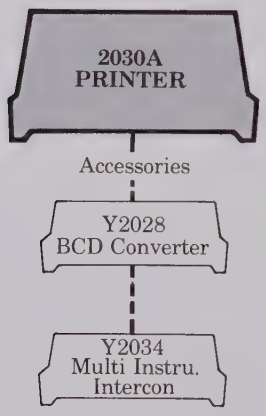
The two diagrams within provide an overview of the options and accessories available for the printers and some typical printing systems. The accompanying table gives you all the specific details including data output options, interconnecting cables, etc.

PTI Printer Product Trees

2020A/2021A UNIVERSAL PRINTER



2030A COMPUTING PRINTER



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Here's How to Use the Table.

You can match any compatible Fluke measurement instrument to a 2020A, 2021A or 2030A printer by using the material in this table. (See the table key for an explanation of symbols.) The examples below will lead you through two typical situations.

Example 1: Printing data from a 2190A Thermometer.

Dots (•) indicate the four printer configurations available: **1**) 2030A **2**) 2020A with parallel ASCII interface **3**) 2020A with RS232C interface **4**) 2020A with PTI Polling Interface. You will need an 002 data output option for the thermometer in addition to either a Y7203 or Y7204 interconnecting cable. (2020A with RS232C interface is an exception; see footnote**.)

Example 2: Printing data from an 8600A DVM (02 data output option).

Again, four printer configurations are available. Three are indicated by dots (•): **1**) 2030A **2**) 2020A with parallel ASCII interface **3**) 2020A with PTI Polling interface. Each of these combinations require a 2010-7015 cable and the Y2028 accessory. The fourth combination is indicated with a square (■) in the BCD interface column. This means that a 2020A/2021A with BCD interface is directly compatible with the 8600A. The Y2028 accessory and the 2010-7007 cable are not required. You must, however, supply a custom BCD Cable.

Multiple Instrument Printing

When more than one measurement instrument is being connected to the 2020A/2021A (with 004 option) or the 2030A, both the Y2034 multi-instrument interconnect accessory and additional cables (Y7203 or Y7204) are required.

Printer configuration data for compatible Fluke instruments.

Measurement Instrument			Y2028* BCD CONVERT. REQUIRED	2030A	2020A/2021A Printer with Interfaces				
Model #	DATA OUTPUT OPTION	CABLE			PARALLEL ASCII −001	RS232C −002	IEEE-488 −003	PTI POLLING −004	BCD −005
THERMOMETERS:									
2190A (PTI)	002	Y7203 or Y7204		•	•	•**		•	
2180A (PTI)	002	Y7203 or Y7204		•	•	•**		•	
2170A SERIES	002	2010-7024	✓	•	•			•	■
2160A SERIES	002	2010-7024	✓	•	•			•	■
DVM'S/ DMM'S:									
8920A SERIES (PTI)	521	Y7203 or Y7204		•				•	
8810A	521	Y7203 or Y7204		•				•	
8800A /8810A	02	2010-7015	✓	•	•			•	■
8600A	521	Y7203 or Y7204		•				•	
8600A	02	2010-7015	✓	•	•			•	■
8400A	03	2010-7007	✓	•	•			•	■
8375A	03	2010-7007	✓	•	•			•	■
8300A	03	2010-7006	✓	•	•			•	■
8200A	06	2010-7004	✓	•	•			•	■
8200A	07	2010-7005	✓	•	•			•	■
8000A	02	2010-7001	✓	•	•			•	
8500A/8502A	05	Y8000 SERIES					•		
8520A		Y8000 SERIES					•		
DATALOGGERS:									
2240B	15	Y8000 SERIES					•		
2240B	12M or 17A	Included w/DOU				•			
2200B	12M	Included w/DOU				•			
COUNTERS:									
7260A SERIES (PTI)	521	Y7203 or Y7204		•				•	
7250A (PTI)	521	Y7203 or Y7204		•				•	
7220A (PTI)	521	Y7203 or Y7204		•				•	
1953A	02	2010-7011	✓	•	•			•	
1953A	15	Y8000 SERIES					•		
1920A	02	2010-7023	✓	•	•			•	
1900A	02	2010-7022	✓	•	•			•	■
Earlier Fluke Instruments									
THERMOMETERS:									
2100A (03 or 06)	02	2010-7017	✓	•	•			•	■
2100A (10)	02	2010-7018	✓	•	•			•	■
DVM'S/ DMM'S:									
8100A/8100B	02	2010-7002	✓	•	•			•	■
8110A	02	2010-7002	✓	•	•			•	■
8120A	02	2010-7003	✓	•	•			•	■
COUNTERS:									
1941A	02	2010A-7009	✓	•	•			•	■
1950A	02	2010A-7009	✓	•	•			•	■
1952A	02	2010A-7009	✓	•	•			•	

TABLE KEY

- • The printer in this column is compatible with the indicated instrument
- ✓ Y2028 BCD Converter accessory is required in conjunction with dotted (•) configurations
- ■ 2020A with BCD interface is directly compatible with the instrument. Y2028 accessory and 2010-7007 cable not required. Customer must, however, supply custom BCD cable

* the Y2028 programmable BCD converter includes an attached output ribbon cable with 36 pin PTI connector.
** Y2026 Cable Adapter and RS232C Cable also required.

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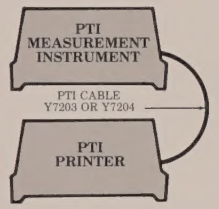
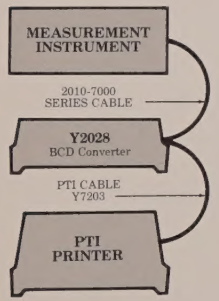
Typical Printing Systems

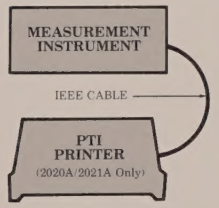
PTI INSTRUMENT PRINTING



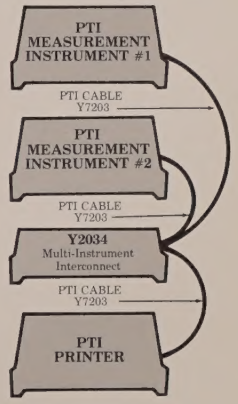
BCD INSTRUMENT PRINTING



IEEE-488 INSTRUMENT PRINTING

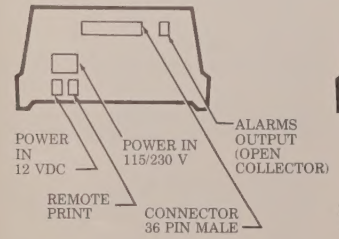


MULTIPLE PTI INSTRUMENT PRINTING

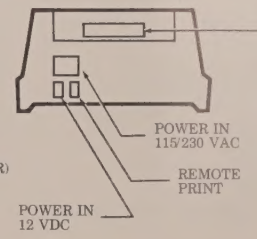


Rear View of Printers and Accessories

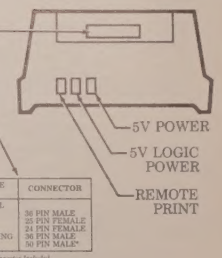
2030A THE COMPUTING PRINTER



2020A THE UNIVERSAL PRINTER



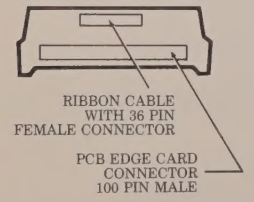
2021A THE UNIVERSAL PRINTER (5V)



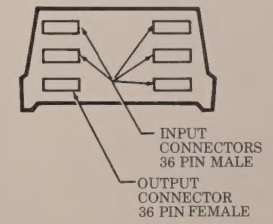
INTERFACE OPTION	CONNECTOR
001 PARALLEL ASCII	36 PIN MALE
002 RS232	25 PIN FEMALE
003 IEEE	24 PIN FEMALE
004 PTI POLLING	36 PIN MALE
005 BCD	50 PIN MALE*

*50 Pin Female Connector Included

Y2028 PROGRAMMABLE BCD CONVERTOR



Y2034 MULTI INSTRUMENT INTERCONNECTOR



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